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Record of Decision:

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Final

Record of Decision for Remedial Action at Operable Unit 11 Ellsworth Air Force Base, South Dakota

United States Air Force
Air Combat Command
Ellsworth Air Force Base

April 1997

AF Project No. FXBM 94-7002

TABLE OF CONTENTS

APPENDICES

LIST OF FIGURES

LIST OF TABLES

1.0 DECLARATION FOR THE RECORD OF DECISION (ROD)

1.1 SITE NAME AND LOCATION

Operable Unit 11 (OU-11), Basewide Ground Water, Ellsworth Air Force Base (EAFB), National Priorities List (NPL) Site.

Meade and Pennington Counties, South Dakota

1.2 STATEMENT OF BASIS AND PURPOSE

This decision document describes EAFB's selected remedial action for OU-11, in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP).

This decision is based on the contents of the Administrative Record for OU-11, EAFB. The U. S. Environmental Protection Agency (EPA) and the South Dakota Department of Environment and Natural Resources (SDDENR) concur with the selected alternative.

1.3 ASSESSMENT OF THE SITE

Actual or threatened releases of hazardous substances from OU-11, if not addressed by implementing the response action selected in this ROD, may present an imminent and substantial endangerment to public health, welfare, or the environment.

1.4 DESCRIPTION OF SELECTED REMEDY

Twelve operable units have been identified at EAFB. This ROD is for a remedial action at OU-11 and is the 14th ROD for EAFB.

OU-11 has been divided into two areas to aid in project planning. Area 1 is the South Docks Study Area, and Area 2 is the BG04 and BG05 Study Areas.

The selected alternative for Area 1, Ground-Water Extraction and Treatment with Containment, includes the following major components:

- Ground-water removal and treatment in the South Docks Study Area.
- On-Base containment of ground water containing contaminants at concentrations above Federal Maximum Contaminant Levels (MCLs) and State of South Dakota Ground-Water Quality Standards.
- Institutional controls and long-term monitoring.

The selected alternative for Area 2, Ground-Water Containment/Extraction and Treatment, includes the following major components:

- Ground-water removal and treatment along the northeast Base boundary and at areas of high contaminant concentrations on-Base.
- Natural attenuation of low contaminant concentration areas, primarily off-Base.
- Alternative water supply to residents affected by contamination coming from the Base.
- Additional investigation to determine the eastern extent of off-Base ground-water contamination.
- Institutional controls and long-term monitoring.

Collectively, the selected remedies for Area 1 and Area 2 constitute the entire remedial action for OU-11 at EAFB.

1.5 STATUTORY DETERMINATION

The selected remedies are protective of human health and the environment, comply with Federal and State of South Dakota requirements that are legally applicable or relevant and appropriate to the remedial action, and are cost-effective. These remedies utilize permanent solutions and alternative treatment technologies, to the maximum extent practicable for OU-11. These remedies satisfy the statutory preference for treatment as a principal element.

A review will be conducted at least every five years after signing the ROD to ensure that the selected remedies continue to provide adequate protection of human health and the environment.

1.6 SIGNATURE AND AGENCY CONCURRENCE ON THE REMEDY

BRETT M. DULA Date
Lieutenant General, USAF
Vice Commander

<IMG SRC 97111A>

Max H. Dodson Date
Assistant Regional Administrator
Office of Ecosystems Protection and Remediation
U.S. Environmental Protection Agency Region 8

NETTIE H. MYERS, Secretary Date
Department of Environment and Natural Resources
State of South Dakota

<IMG SRC 97111B>

2.0 DECISION SUMMARY

2.1 SITE NAME AND LOCATION

EAFB is a U. S. Air Force Air Combat Command (ACC) installation located 12 miles east of Rapid City, South Dakota, and adjacent to the small community of Box Elder (Figure 1).

EAFB covers approximately 4,858 acres within Meade and Pennington Counties and includes runways and airfield operations, industrial areas, and housing and recreational facilities (Figure 2). Open land, containing a few private residences, lies adjacent to EAFB on the north, south, and west, while residential and commercial areas lie to the east of the Base.

2.2 OU-11 DESCRIPTION/HISTORY AND REGULATORY OVERSIGHT ACTIVITIES

2.2.1 EAFB Description/History

EAFB was officially activated in July 1942 as the Rapid City Army Air Base, a training facility for B-17 bomber crews. It became a permanent facility in 1948 with the 28th Strategic Reconnaissance Wing as its host unit. Historically, EAFB has been the headquarters of operations for a variety of aircraft, as well as the Titan I Intercontinental Ballistic Missile, and the Minuteman I and Minuteman II missile systems. The Air Force has provided support, training, maintenance, and/or testing facilities at EAFB. Presently, the 28th Bombardment Wing (B-1B bombers) is the host unit of EAFB.

2.2.2 OU-11 Site Description/History

The OU-11 areas of investigation, indicated on Figure 2 and Table 1, are defined in this report as:

- The Basewide Ground-Water Study
- The Basewide Ecological Evaluation
- The area surrounding well MW93BG04 (BG04)
- The area surrounding well MW93BG05 (BG05)
- Upgradient of OU-6, near well MW930602
- The South Docks Area
- The northern edge of OU-12
- Additional investigations at OU-7
- The Pond 003 Area
- Ground water at OU-8

The Basewide Ground-Water Study listed above was a study of the overall ground-water quality and characteristics. This study is presented in the OU-11 Remedial Investigation Report. The remainder of the areas listed above were investigated as part of OU-11 to fill ground-water data gaps that remained after completion of the investigations at the other 11 OUs at EAFB, or to further investigate areas of isolated contamination.

Based on the risk assessment and an evaluation of the data collected as part of the Basewide Ground-Water Study and the studies of the additional areas listed above, it was determined that three areas warrant remediation as follows: the area surrounding well BG04, the area surrounding well BG05, and the South Docks Study Area. In addition, long-term monitoring is needed for the ground water at OU-8. The other areas investigated (upgradient OU-6, northern edge of OU-12, OU-7 [additional investigation], and the Pond 003 area) did not warrant remediation because no potential chemicals of concern (COCs) were detected or because only isolated occurrences of low concentrations of potential COCs were detected. Areas that do not warrant remediation are not discussed in this ROD. Detailed information on the investigation of these areas can be found in the OU-11 remedial investigation and feasibility study (RI/FS) reports and specific OU reports.

To facilitate project planning, OU-11 has been divided into two parts, Area 1 and Area 2. Area 1 is the South Docks Study Area. Area 1 includes the South Docks and areas of ground-water contamination in OU-9 that were deferred to OU-11. Ground-water contamination at OU-10 was also deferred to OU-11 for remediation; however, ground-water contamination at OU-10 is the result of petroleum product releases and will be addressed through the State of South Dakota Petroleum Release Program. Contaminated ground water in Area 1 lies entirely on-Base. Remedial alternatives for these areas are collectively referred to as "South Docks" alternatives since the South Docks area is the primary area of contamination in Area 1. Area 2 is the areas around wells BG04 and BG05, which includes areas where ground-water contamination has been found to leave the Base along the eastern boundary. Area 2 will be referred to as the BG04/BG05 Study Area. The long-term monitoring of the ground water at OU-8 will be performed separately from the Area 1 and Area 2 remedial actions.

2.2.2.1 Area 1

South Docks Study Area

The South Docks Area is located in the central part of the Base between OU-9, OU-10, and the flightline area. Buildings of interest in this general vicinity include the Pride Hangar and hangars in Rows 20, 30, 40, and 50.

Historical aerial photographs indicate that the Pride Hangar and the hangars in the South Docks Area have been in place since the late 1940s to early 1950s. Historically, the hangars have been used for docking and maintenance of aircraft. The Pride Hangar is now used for storage and maintenance of missile-support equipment and for offices and meeting rooms. In 1992, several underground storage tanks (USTs) were removed at the Pride Hangar. Hangars in the South Docks are now used for storage and maintenance of various support equipment, including aircraft refueling vehicles, fire-fighting vehicles, grounds-keeping equipment, and periodic parking for aircraft.

Other potential sources in the area include industrial waste lines, equipment wash racks, and historical chemical handling and disposal practices. However, no specific incidents of hazardous material spills have been documented.

2.2.2.2 Area 2

BG04 Study Area

The BG04 Study Area is located in an open area at the northeast edge of EAFB, approximately 1,500 ft south of the explosive ordnance disposal (EOD) debris burial area perimeter (OU-8). There are no known sources of contaminants in the immediate vicinity of BG04. A firing range is located approximately 1,200 ft to the northwest and a housing tract is located approximately 800 ft to the east of monitoring well MW93BG04.

BG05 Study Area

The BG05 Study Area is located in a housing area in the east-central portion of EAFB, approximately 300 ft east of LeMay Boulevard and continues off-Base to the east. There are no known sources in the immediate vicinity of well BG05.

2.2.2.3 Ground Water at OU-8

Ground water at OU-8 was evaluated as part of OU-11. Ground-water remediation is not warranted in this area; therefore a detailed analysis of alternatives was not conducted for ground water at OU-8. However, to comply with State landfill closure requirements, compliance monitoring will be implemented to verify that chemical concentrations in the ground water do not pose unacceptable risk. Compliance monitoring at OU-8 will have an associated cost and will consist of installation of monitoring wells and sampling and analysis of ground water. At this time, OU-8 is the only area that does not require remediation that is specifically selected for compliance monitoring; however, during development of the OU-11 long-term ground-water monitoring plan, additional areas may be identified where long-term monitoring is required to fill existing data gaps.

2.2.3 EAFB Hydrogeology

A shallow unconfined aquifer has been identified at depths of 10 feet to 50 feet beneath the ground surface at EAFB. The shallow unconfined aquifer at EAFB is considered a Federal Class II-B (potential source of drinking water) aquifer and potentially a Class II-A (discharge to surface water) aquifer (EPA, 1986). The ground water is also classified as having a beneficial use as a drinking water supply suitable for human consumption according to State of South Dakota (State) rules (ARSD Chapter 74:03:15, Groundwater Quality Standards).

Deep bedrock aquifers also exist beneath EAFB. These deep aquifers are separated from the shallow aquifer by 800 feet of low-permeability clays and silts; therefore, these aquifers are not areas where contamination will exist. In the past, EAFB used these deeper aquifers for its water supply. Presently, EAFB obtains its potable water from the Rapid City Municipal Distribution System.

2.2.4 Regulatory Oversight Activities

Environmental investigation activities at EAFB were initiated by the Air Force in 1985 through an Installation Restoration Program (IRP) Phase I Installation Assessment/Records Search and Phase 11,

Confirmation/Quantification. The Phase I study, dated September, 1985, identified a total of 17 locations at EAFB where releases involving hazardous substances potentially occurred.

In Phase II of the IRP investigation, field activities included soil vapor surveys, geophysical surveys, surface and subsurface soil sampling, ground-water sampling, ground-water hydrologic testing, and ecological investigations.

On August 30, 1990 (55 Federal Register 35509), EAFB was listed on the EPA's National Priorities List (NPL). A Federal Facilities Agreement (FFA) was signed in January 1992 by the Air Force, EPA, and the State of South Dakota, and went into effect on April 1, 1992. The FFA establishes a procedural framework and schedule for developing, implementing, and monitoring appropriate response actions for EAFB in accordance with CERCLA, as amended by SARA, and the NCP. It also sets out the oversight procedures for EPA and the State to ensure Air Force compliance with the specific requirements. The FFA identified 11 site-specific OUs and a Base-wide ground-water OU, which is OU-11. The Base-wide ground-water OU, is primarily used to address contaminated ground water that was not addressed during the investigation of a site-specific OU.

Listing on the NPL and execution of the FFA required the U.S. Air Force to perform a remedial investigation/feasibility study (RI/FS) to investigate the 12 operable units. During 1993 through 1996, an extensive RI field program was conducted to characterize conditions at OU-11. The program included: a soil vapor survey, geophysical survey using electromagnetics, drilling and sampling of boreholes, installation of monitoring wells, slug testing of monitoring wells, ground-water sampling, geotechnical analysis of soil samples, ecological evaluation, assessment of human health risks, and review and compilation of previous IRP investigations. Collection and laboratory analysis of soil, ground-water, and sediment samples were included in the RI field program.

2.3 HIGHLIGHTS OF COMMUNITY PARTICIPATION

Community relations activities that have taken place at EAFB to date include:

- FFA process - After preparation of the FFA by the USAF, EPA, and SDDENR, the document was published for comment. The FFA became effective April 1, 1992.

- Administrative Record - An Administrative Record for information was established in Building 8203 at EAFB. The Administrative Record contains information used to support USAF decision-making. All the documents in the Administrative Record are available to the public.

- Information repositories - An Administrative Record outline is located at the Rapid City Library (public repository).

- Community Relations Plan (CRP) - The CRP was prepared and has been accepted by EPA and the State of South Dakota and is being implemented. This plan was updated in 1996.

- Restoration Advisory Board (RAB) - The RAB has been formed to facilitate public input in the cleanup and meets quarterly. In addition to USAF, EPA, and South Dakota oversight personnel, the RAB includes community leaders and local representatives from the surrounding area.

- Mailing list - A mailing list of all interested parties in the community is maintained by EAFB and updated regularly.

- Fact sheet - A fact sheet describing the status of the IRP at EAFB was distributed to the mailing list addressees in 1992. A remedial design fact sheet was distributed in October 1996.

- Open house - An informational meeting on the status of the IRP and other environmental efforts at EAFB was held on May 6, 1993. An open house format was also used during the November 16, 1995 Restoration Advisory Board meeting. In addition, during 1996 the Air Force has met with community members numerous times to inform them about ongoing investigations at OU-11.

- Newspaper articles - Articles have been written for the Base newspaper regarding IRP activity.

- Proposed Plan - The proposed plan on this action was distributed to the mailing list addressees for their comments.

A public comment period was held from February 10 to March 12, 1997, and a public meeting was held on February 19, 1997. At this meeting, representatives from EAFB answered questions about the remedial action. A response to the comments received during this period is included in the Responsiveness Summary, which is part of this Record of Decision (ROD).

This ROD is based on the contents of the Administrative Record for OU-11, in accordance with CERCLA, as amended by SARA, and the NCP. The RI/FS reports and the Proposed Plan for OU-11 provide information about OU-11 and the selected remedy. These documents are available at the Information Repositories at EAFB and the Rapid City Public Library.

2.4 SCOPE AND ROLE OF RESPONSE ACTION

The FFA identified 11 site-specific OUs and a Basewide ground-water OU. The 12 operable units are identified as follows:

OU-1	Fire Protection Training Area
OU-2	Landfills Nos. 1 and 6
OU-3	Landfill No. 2
OU-4	Landfill No. 3
OU-5	Landfill No. 4
OU-6	Landfill No. 5
OU-7	Weapons Storage Area
OU-8	Explosive Ordnance Disposal Area (Pramitol Spill)
OU-9	Old Auto Hobby Shop Area
OU-10	North Hangar Complex
OU-11	Basewide Ground Water
OU-12	Hardfill No. 1

The remedial action objectives (RAOs) for OU-11 are:

- Prevent future human exposure to on-Base ground water with contaminants exceeding State of South Dakota Ground-Water Quality Standards and Federal MCLs.

- Prevent additional ground water containing contaminants above State of South Dakota Ground-Water Quality Standards and Federal MCLs from moving off-Base. Prevent human exposure to off-Base ground water with contaminants exceeding State of South Dakota Ground-Water Quality Standards and Federal MCLs.

The area of attainment defines the area over which preliminary remediation goals would be achieved, and is based on the RAOs. The areas of attainment for ground water at OU-11 are illustrated on Figures 3 through 6.

2.5 SITE CHARACTERISTICS

The OU-11 investigation included an evaluation of data collected from other OUs. The OU-11 study also included areas of potentially contaminated ground water which were not OUs or State petroleum release investigation sites. As previously discussed, not all of these areas require remediation. This section briefly discusses and summarizes the distribution of COCs, potential routes of exposure, and current risks associated with the study areas of OU-11 that require action. Only organic chemicals are discussed since the inorganic chemicals detected in these areas are the result of natural geologic formations.

2.5.1 Distribution of Contaminants

The following sections discuss the COCs in Area 1 and Area 2.

2.5.1.1 Area 1

South Docks Area

Volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), and hydrocarbons, as total petroleum hydrocarbons (TPH), were reported in ground-water samples from the South Docks Area. TCE was the most frequently reported VOC in 29 of 39 ground-water samples, at concentrations ranging from 1 Ig/L to 7,000 Ig/L. The TCE degradation product, total-1,2-dichloroethene, was detected in 18 of 39

ground-water samples, at a maximum concentration of 73 Ig/L. Chloroform was detected in 8 of 39 samples, at a maximum concentration of 200 Ig/L. These three contaminants were also reported above their respective MCLs and State standards in at least one sample each. The SVOCs pentachlorophenol and chrysene were reported at concentrations above the MCL and State standard in one ground-water sample. TPH was reported in eight samples. The maximum reported concentration of TPH was 2,500 Ig/L.

2.5.1.2 Area 2

BG04 Area

TPH reported as jet fuel (JP-4), trichloroethene (TCE), and 1,2-dichloroethene (DCE) were reported in the ground-water sample collected from well MW93BG04 on June 15, 1993. Additional sampling was conducted during the OU-11 R1 to determine the lateral extent of these contaminants.

Contaminants reported in ground water in the BG04 area included jet fuel, chlorinated hydrocarbons, and benzene, toluene, ethylbenzene, xylenes (BTEX). The most frequently reported chlorinated hydrocarbon was TCE, which was reported in five samples on-Base at a maximum concentration of 110 Ig/L. Both TCE and PCE were reported at concentrations above MCLs and State standards. Based on site geology and the shape of the TCE plume, the firing range was suspected as a potential source of the TCE in the ground water. However, additional investigations conducted in 1996 (including soil vapor surveys, electromagnetic surveys, test pits, and historic literature searches) failed to locate a source of the TCE. Based on the relatively low concentrations of COCs detected in this area, it is anticipated that a major source in this area is probably not likely.

Additional ground-water investigations (BG04 Pre-Design Site Investigation, USAF, 1996) have been conducted in off-Base areas beyond the northeast Base boundary to determine the extent of off-Base contamination. Figures 8 and 9 illustrates the distribution contamination in the off-Base areas. The Air Force believes that based on ground-water data collected from this area during the Pre-Design Investigation, there may be at least two distinct contaminant areas in the off-Base region. The heavy, dashed line illustrated on Figures 8 and 9 indicates the Air Force's estimated dividing line (based on the pre-design data) between areas suspected of being contaminated from on-Base sources and those potentially contaminated from off-Base sources. This ROD addresses off-Base areas west of this dividing line only; however, it is recognized that the above estimates are based on preliminary data from the off-Base areas and that the "dividing line" may change based on additional data collected. Additional investigations that are part of the selected remedy will determine the extent of contamination in this area and will help further refine estimates of the ground water relationships in this area. The area of ground-water contamination resulting from contaminants moving from the Base may include areas to the east of the line indicated in the figures. If this would be the situation, the remedial action will address the newly identified area of contamination. The BG04 Pre-Design Site Investigation Report and the Addendum to the BG04 Pre-Design Site Investigation Report contain detailed information regarding the off-Base investigation.

BG05 Area

TPH and TCE were reported in the ground-water sample collected from well MW93BG05 on 15 June 1993. Additional sampling was conducted during the OU-11 RI to determine the lateral extent of these contaminants. TCA was reported at a concentration of 0.8 Ig/L and TCE was reported at a concentration of 7.0 Ig/L, slightly above the MCL and state standard of 5.0, Ig/L.

Additional ground-water investigations (BG04 Pre-Design Site Investigation, USAF, 1996) have been conducted in off-Base areas beyond the northeast Base boundary to determine the extent of off-Base contamination. Figure 8 illustrates the distribution TCE in the off-Base areas. Figure 9 illustrates distributions of other VOCs (DCE, trichloroethane [TCA], PCE) detected in these off-Base areas. Additional investigations, as part of this ROD, will determine the extent of contamination in this area and further refine estimates of the ground water relationships in this area. The source of the contaminants in the BG05 area is not known.

2.6 SITE RISK SUMMARY

2.6.1 Human Health Risks

A quantitative human health risk assessment (HHRA) was completed for OU-11. The risk assessment evaluated potential effects on human health posed by exposure to contaminants within OU-11. The OU-11 HHRA was designed to provide three discrete sets of information:

- Risk to human health for two areas of concern, the South Docks Area and the BG04 Area,
- Estimation of the contaminant effects at four areas (upgradient OU-6, North OU-12, BG05, and Pond 003) after additional data collection.
- A comprehensive Basewide Ground-Water Risk Assessment, summarizing all quantitative ground-water risk estimates and associated risk "drivers" for each OU, area of concern, and supplemental data collection effort.

2.6.2 Risk Assessment Process

The assessment of human health risks for this OU considered the following topics:

(1) Contaminants of concern (COCs) in ground-water samples collected at OU-11.

(2) Current and future land-use conditions.

(3) Potential environmental pathways by which populations might be exposed.

(4) Estimated exposure point concentrations of COCs.

(5) Estimated intake levels of the COCs.

(6) Toxicity of the COCs.

(7) Uncertainties in the assessments of exposure, toxicity, and general risks.

2.6.3 Exposure Assessment

Exposure pathways by which human populations may be exposed to the COCs in ground water were identified during the OU-11 Risk Assessment. Exposure pathways generally consist of the following four elements:

1) A source and mechanism of release.

2) A retention or transport medium.

3) A point of potential human contact with the medium.

4) An exposure route at the contact or exposure point.

An exposure pathway is considered complete only if each of these elements are present. The South Docks (Area 1) and BG04/BG05 (Area 2) areas themselves may serve as sources, while ground water is the transport media. Exposure pathways under both current and future land use scenarios were evaluated. Current land use onsite for Area 1 and Area 2 was assumed to be associated with Base activities. Current land use offsite (off-Base), where relevant, was assumed to be residential. Future land use at both Area 1 and Area 2 (onsite and offsite) was assumed to be residential for purposes of conservatism. Receptors of concern are primarily residents who will reside in these areas under future land use.

The potential for complete exposure pathways to exist under both current and future land use scenarios, was evaluated for each area. For these land uses, the potential for receptors of concern to be engaged in activities that could bring them into contact with shallow ground water potentially contaminated with COCs, was evaluated for several exposure routes to determine the potential exposure groups. Carcinogenic and noncarcinogenic risks were calculated for three potential exposure groups. These exposure groups are referred to as residential adults. Long term (30 years) exposure to residential adults is believed to be the most appropriate potential exposure group for ground water at OU-11. In general, if protection of this exposure group is afforded, protection of other potential exposure groups would also be afforded. The exposure groups are as follows:

(1) The future residential adult living in the South Docks area who is exposed to shallow ground water.

(2) The future residential adult living on-Base in the BG04/BG05 area who is exposed to shallow ground water.

(3) The residential adult living off-Base in the BG04/BG05 area who is exposed to shallow ground water.

Table 2 summarizes contaminants, detection frequencies, and other pertinent data that were used to develop a list of COCs for the OU-11 additional study areas. The list of COCs represents the ground-water specific list of chemicals that met specific screening criteria and were carried through the risk analysis to quantify the potential risk posed to humans from site-related exposures. Ingestion of ground water, inhalation of COCs in ground water, and dermal contact with ground water were all considered in the exposure assessment. The 95 percent upper confidence limit mean (UCLM) concentrations have been estimated and were used as the exposure point concentrations to provide reasonable maximum exposure (RME) risk estimates. The calculated exposure point concentrations were used to calculate estimates of the average daily intakes (intake) for all COCs. Intakes are expressed as the amount of chemical taken into the body per unit body weight per unit time (e.g., mg/kg-day), and are based on chemical concentrations in a specific medium, intake quantity per unit time, exposure frequency and duration, and body weight. The exposure frequency and duration used to calculate the RME risk were 350 days/year and 30 years, respectively. Adult body weight was assumed to be 70 kg.

2.6.4 Toxicity Assessment

Slope factors (SFs) have been developed by EPA's Carcinogenic Assessment Group for estimating excess lifetime cancer risks associated with exposure to potentially carcinogenic chemicals. SFs, which are expressed in units of (mg/kg-day) -1, are multiplied by the estimated intake of a potential carcinogen, in mg/kg-day, to provide an upper-bound estimate of the excess lifetime cancer risk associated with exposure at that intake level. The term "upper bound" reflects the conservative estimate of the risks calculated from the SF. Use of this approach makes underestimation of the actual cancer risk highly unlikely. Slope factors are derived from the results of human epidemiological studies or chronic animal bioassays to which animal-to-human extrapolation and uncertainty factors have been applied.

Reference doses (RfDs) have been developed by EPA for indicating the potential for adverse health effects from exposure to chemicals exhibiting noncarcinogenic effects. RfDs, which are expressed in units of mg/kg-day, are estimates of lifetime daily exposure levels for humans, including sensitive individuals. Estimated intakes of chemicals from environmental media (e.g., the amount of chemical ingested from contaminated drinking water) can be compared to the RfD. RfDs are derived from human epidemiological studies or animal studies to which uncertainty factors have been applied (e.g., to account for the use of animal data to predict effects on humans). These uncertainty factors help ensure that the RfDs will not underestimate the potential for adverse noncarcinogenic effects to occur. The RfDs and SFs for COCs are presented in Tables 3 and 4 for Area 1 and Area 2, respectively.

Excess lifetime cancer risks are determined by multiplying the intake level with the slope factor. These risks are probabilities that are generally expressed in scientific notation (e.g., 1x10 -6). An excess lifetime cancer risk of 1x10 -6 indicates that, as a plausible upper bound, an individual has a one in one million chance of developing cancer as a result of site-related exposure to a carcinogen over a 70-year lifetime under the specific exposure conditions at a site. According to the NCP and EPA's Risk Assessment Guidance for Superfund (EPA/540/1-89/002) the acceptable carcinogenic risk range is between 1x10 -4 to 1x10 -6. Depending upon site-specific information, remediation may or may not be warranted if the total site risk lies within the acceptable risk range.

Potential concern for noncarcinogenic effects of a single contaminant in a single medium is expressed as the hazard quotient (HQ) (or the ratio of the estimated intake derived from the contaminant concentration in a given medium to the contaminant's reference dose). By adding the HQs for all contaminants within a medium or across all media to which a given population may be reasonably exposed, the Hazard Index (HI) can be generated. The HI provides a useful reference point for gauging the potential significance of multiple contaminant exposures within a single medium or across media.

Tables 3 and 4 summarize the noncarcinogenic and carcinogenic risks for the South Docks (Area 1) and BG04/BG05 Study Areas (Area 2), respectively.

2.6.5 Basewide Ecological Risk Assessment

A Basewide ecological evaluation was also conducted as part of OU-11. Based on the size of the individual OUs and the nature and use of the localized areas by potential receptors, detailed OU-specific assessments of ecological risks were not warranted during the OU RIs. Therefore, a Basewide Ecological Risk Assessment was conducted as part of OU-11. This study considered impacts to the environment as a whole at EAFB and incorporated data collected during the individual OU studies. The study concluded that terrestrial and aquatic risks are low Basewide; therefore, remediation of ecological risk is not warranted. Volume III of the Final RI Report for OU-11 presents the complete Basewide Ecological Risk Assessment.

2.6.6 Risk Assessment Conclusions

At Area 1, the total carcinogenic risk to potential future residents from ingestion, inhalation, and dermal contact with contaminated ground water is 1.77x10 -4. This risk level exceeds the acceptable risk range of 1x10 -4 to 1x10 -6. At Area 2, the total carcinogenic risk to potential future residents from ingestion, inhalation, and dermal contact with contaminated ground water is 2.27x10 -5. This risk level is within the acceptable risk range. However, the ground water at Area 2 contains contaminants at concentrations greater than the MCL and contaminants have already moved beyond the Base boundary. Remediation of ground water in Area 1 and Area 2 is warranted because of the unacceptable risk to human health from exposure to contaminated ground water and to prevent further offsite movement of ground water containing contaminants at concentrations greater than the State of South Dakota Ground-Water Quality Standards or Federal MCLs. Actual or threatened releases of hazardous substances from OU-11, if not addressed by implementing the response action selected in this ROD, may present an imminent and substantial endangerment to public health, welfare, or the environment.

2.7 DESCRIPTION OF ALTERNATIVES

In developing remedial alternatives for OU-11, information from feasibility studies (FSs) at other OUs (and several additional areas of study) was compiled and examined to help develop response actions for OU-11. Many of these other OUs (e.g., OUs 1, 4, and 9) had contaminated ground water within their boundaries. At OUs 1 and 4, ground-water alternatives were developed to address localized ground-water contamination. At OU-9, the extent of ground-water contamination was large and/or the contamination originated outside the boundaries of the OU. Remediation of ground water at OU-9 was deferred to OU-11.

The development of alternatives for OU-11 was conducted in part using EPA's Presumptive Remedies Approach Presumptive Response Strategy and Ex-Situ Treatment Technologies for Contaminated Ground Water at CERCLA Sites (OSWER Directive 9283.1-12). This allows for a streamlined selection of alternatives for remediation by using preferred technologies based on historical patterns of remedy selection and EPA's scientific and engineering evaluation of performance data on technology implementation. Use of the presumptive remedy does not preclude the analysis of other technologies.

A brief description of the major components each ground-water remedial action alternative is presented below. The alternatives are presented for Area 1 and Area 2, respectively.

2.7.1 Area 1 Alternatives

Alternative 1 - No Action

- The No Action Alternative is presented as a baseline to which other remedial measures are compared. The EPA, through the March 1990 National Contingency Plan (NCP) revisions, requires that the No Action Alternative option be examined in detail during the remedial alternatives evaluation phase. Under this alternative, no treatment or containment of contaminated ground water would be conducted.

Alternative 2 - Natural Attenuation with Supplemental Source Removal and Treatment

Treatment Components

- Contaminant concentrations will be reduced through natural attenuation throughout most of Area 1. Natural attenuation processes include chemical (biodegradation, chemical and biochemical stabilization) and physical processes (dispersion, dilution, sorption, volatilization).

- Supplemental ground-water extraction would be conducted in the areas of highest contamination (generally areas with TCE concentrations greater than 100 ppb). Based on ground-water flows and using a conservative radius of influence of 50 ft, it is estimated that 13 extraction wells would be required in these areas. Ground-water removal and treatment would continue until all contaminant concentrations are below the regulatory standard or until the removal and treatment of the ground water is no longer effective.

- Removed ground water would be treated using a stand-alone onsite air stripper with carbon offgas treatment or an activated carbon treatment unit. Existing ground-water treatment facilities at the Base may be used to treat removed ground water, if feasible

- Treated ground water would be discharged to a surface drainage, the Base waste water treatment plant (WWTP), or injected back into the aquifer. The discharge option will be

determined during the remedial design phase. The main criteria for determining the preferred discharge option effects on existing surface drainage areas and cost effectiveness. For cost estimate purposes it is assumed that discharge would be to the Base WWTP.

General Components

- Institutional controls would be implemented to prevent the use and consumption of untreated ground water containing chemicals above MCLs and limit development on-Base. Institutional controls would include: (1) issuing a continuing order to restrict onsite worker access to contaminated soil/ground water; (2) filing a notice to the deed detailing the restrictions of the continuing order and ground-water well restrictions; and (3) a covenant to the deed in the event of property transfer.

- Long-term ground-water monitoring would be used to monitor the movement of contaminants in the ground water and to monitor the effectiveness of natural attenuation. Monitoring would be conducted using a combination of new and existing wells and would be implemented as part of the Basewide, long-term ground-water monitoring plan. It is estimated that 12 new monitoring wells would be installed and 30 wells would be sampled and analyzed each sampling round in this area. Sampling would initially be conducted on a quarterly basis, with the potential to reduce the frequency at a later time, if warranted. Ground-water samples would be analyzed for VOCs, SVOCs, TPH, and natural attenuation parameters. Ground-water monitoring will be continued until ground-water concentrations are below State of South Dakota and Federal MCLs.

- Ground-water sampling results will be used to verify that natural attenuation is reducing contaminant concentrations in the ground water at a rate that is protective of human health and the environment. If, during subsequent reviews, sampling results indicate that contaminant concentrations in the ground water are not being reduced through natural attenuation, prior to movement off-Base, the pump and treat portion of this alternative would be expanded to treat additional areas of contaminated ground water. A 50 percent cost contingency has been included in this alternative to cover the potential added cost of expanding the system. Ground-water monitoring will be continued until ground-water concentrations are below State of South Dakota and Federal MCLs.

- Implementation of this alternative does not pose any unusual or extraordinary conditions. Based on estimates of remediation time frames for Area 2, which has similar soil characteristics as Area 1, it is estimated that natural attenuation would reduce contaminant concentrations to levels below MCLs in approximately 20 years. Ground-water data in the South Docks area indicate that natural attenuation is taking place. The data indicate that contaminant concentrations have been decreasing during the last four years. It is estimated that the supplemental extraction wells would be operated for 1-3 years, based on the estimated volume of ground water present in these areas. These estimates would be refined during remedial design.

Major ARARs

- A risk assessment was conducted for OU-11; however, the COCs for Area 1 have Federal and State MCLs. The Federal and State MCL for TCE is 5 ppb. Ground water would be treated until MCLs are met. If necessary, offgas emissions from air strippers would be treated to meet requirements of the Clean Air Act (CAA) and State air quality requirements. Ground water would be further treated, if necessary, to meet Clean Water Act (CWA) requirements for surface water discharges of treated ground water. Wastes (e.g., drill cuttings) generated during implementation would be disposed of in accordance with RCRA Hazardous Waste requirements, if necessary.

<u>Alternative 3 - Ground-Water Extraction and Treatment with Containment</u>

Treatment Components

- A combination of extraction wells and/or trenches would be used to remove contaminated ground water in Area 1. Wells and/or trenches would be located throughout Area 1. Some wells would be located in the Pride Hangar area where the concentration of contaminants is the highest. Some wells may also be located as containment wells to prevent off site movement of contaminants. Based on ground-water data from the South Docks area, it is estimated that 5 extraction wells would be located in the Pride Hangar area. It is estimated that 20 extraction wells and approximately 1,100 lineal feet of

interceptor/extraction trenches would be installed in the main area of the South Docks (i.e., Rows 20 through 50) and the OU-9 area.

- Removed ground water would be treated using a combination of air strippers with carbon offgas treatment and activated carbon treatment units. Based on the predicted ground-water flow from the extraction wells and trenches, it is estimated that three treatment units would be required. For cost estimate purposes, it is assumed two air stripper units and one carbon unit would be used.

- Treated ground water would be discharged as described in Alternative 2.

General Components

- Institutional controls as described in Alternative 2 would be 'Implemented as part of this alternative.

- Long-term ground water monitoring to detect potential movement of contaminants and to determine the effectiveness of the alternative would be implemented. Long-term ground-water monitoring would be the same as described in Alternative 2, except that natural attenuation monitoring would not be conducted. It is estimated that 12 new monitoring wells would be installed and a total of 20 wells (new and existing) would be sampled each sampling round in this area.

- This alternative could be implemented using standard methods and equipment that are readily available. Based on the volume of ground-water to be treated in the South Docks/OU-9 areas, and considering the influence of the extraction wells, it is estimated that it would take 5-10 years to remediate ground water in Area 1. Predesign studies would be conducted to finalize design parameters and determine the number and placement of wells.

Major ARARs

The major ARARs for this alternative are the same as those described in Alternative 2.

Alternative 4 - Aquifer Air Sparging (AAS)/Soil Vapor Extraction (SVE)

Treatment Components

- AAS would be used to remove contaminants out of the ground water and transport them into the unsaturated zone where they would be removed using SVE. AAS/SVE wells would be located only in the areas of highest contaminant concentrations (generally those areas with TCE concentrations above 100 ppb). Based on data collected from other studies at EAFB (CAP, ST-21), it is estimated that approximately 1,050 AAS and 975 SVE wells would be required to treat the areas of highest contamination.

- Extracted vapors would be treated using a vapor-phase carbon adsorption system.

- Natural attenuation will reduce concentrations of contaminants in the ground water in areas of lesser contamination that are not being actively addressed with AAS/SVE. The application of natural attenuation is described under Alternative 2.

General Components

- Institutional controls as described in Alternative 2 are part of this alternative.

- Long-term ground water monitoring to detect potential movement of contaminants, to determine the effectiveness of the alternative, and to monitor natural attenuation would be implemented. Long-term ground-water monitoring would be the same as described in Alternative 2.

- AAS is an in situ treatment process; therefore, there is no ground water to discharge. AAS/SVE may be difficult to implement over large areas because of the large number of wells required and the potential for short circuiting. A pilot test will be required to determine whether AAS/SVE can be implemented and if so, to determine the final design parameters of the system. The large areal extent of the contaminant plumes will require a large number of AAS and SVE wells. The implementation of this alternative assumes that separate AAS and SVE systems would be installed; however, there is the potential reduce costs by overlapping system components. For cost purposes, it is estimated that the AAS/SVE

systems would require five years of operation; however, this estimate would be refined during pilot studies. As discussed above, reduction of contaminant concentrations in the ground water to levels below MCLs through natural attenuation is estimated to take 20 years.

Major ARARs

- Ground water would be treated until MCLs are met. Emissions from vapor-phase carbon treatment units would meet requirements of the Clean Air Act (CAA) and state air quality requirements. Because AAS is an in situ process, there is no ground water to discharge. Wastes (e.g., drill cuttings) generated during implementation would be disposed of in accordance with RCRA Hazardous Waste requirements, if necessary.

Alternative 5 - Containment

Treatment Components

- Ground-water extraction wells and trenches would be used to contain contaminated ground water onsite. Extraction wells and trenches would be located along the leading edges of the contaminant plumes to intercept contaminated ground water before it moves offs1te. Wells and trenches would be located along the eastern and southern edges of the TCE plume. Based on a conservative estimated radius of influence of 50 ft, approximately 25 extraction wells would be located along the eastern edge of the contaminant plume.

- The 400-ft interceptor trench, constructed as part of the Corrective Action Plan (CAP) implemented to address jet fuel releases from the flightline area, would be incorporated into this alternative. The existing trench, located near the southern leading edge of the contaminant plume, would be extended approximately an additional 400 ft to the east-northeast.

- Removed ground water would be treated using a combination of air strippers with carbon offgas treatment (two units estimated) and activated carbon treatment units (one unit estimated), similar to Alternative 3.

- Treated ground water would be discharged as described in Alternative 2.

General Components

- Institutional controls as described in Alternative 2 would be implemented as part of this alternative.

- Long-term ground water monitoring as described under Alternative 3 would be implemented.

- This alternative could be implemented using standard methods and equipment that are readily available. It is estimated that movement of contaminants in the ground water to the containment wells/trenches (where they will be extracted and treated) would take 50-75 years. However, natural attenuation is estimated to reduce chemicals in the ground water to levels below MCLs in approximately 20 years. The system would have to be operated for 20 years before ground water is below MCLs. A predesign study would be conducted to further refine these estimates.

Major ARARs

The major ARARs for this alternative are the same as those described in Alternative 3.

2.7.2 Area 2 Alternatives

Alternative 1 - No Action

- The No Action Alternative is described under Area 1, Alternative 1.

Alternative 2 - Natural Attenuation with Supplemental Source Removal and Treatment

Treatment Components

- Contaminant concentrations (primarily TCE) will be reduced through natural attenuation throughout most of Area 2, including both the on-Base and off-Base areas.

- Supplemental ground-water extraction in the areas of highest contamination (on-Base in the central BG04 area where TCE concentrations are greater than 100 ppb). Based on ground-water flows and the BG04 Pre-Design Site Investigation, it is estimated that 6 extraction wells would be required in these areas. Ground-water removal and treatment would continue until all contaminant concentrations in this area are below the regulatory standard or until the removal and treatment of the ground water no longer is effective.

- Extracted ground water would be treated using a stand-alone onsite air stripper with carbon offgas treatment, or an activated carbon treatment unit.

- Treated ground water would be discharged to surface drainage, the Base waste water treatment plant (WWTP), or injected back into the aquifer. For cost estimate purposes it is assumed that discharge would be to the Base WWTP.

General Components

- Institutional controls similar to those described under Area 1, Alternative 2 would be implemented on-Base.

- Institutional controls off-Base may consist of requiring restrictive easements, providing alternative potable water supplies to off-Base residents whose drinking water wells may be impacted by ground water contaminants from the Base, and/or other measures. EAFB currently has a proactive program in which they will provide, at no cost, an alternative potable water supply to off-Base residents whose drinking water has been adversely impacted by Base activities. This program is administered on a case-by-case basis and consists of agreements with individual landowners. The program will be incorporated as part of this alternative (and all subsequent Area 2 alternatives), if necessary, and will be continued (on a case-by-case basis) until the ground water is safe to drink, which is estimated to be up to 16 years (see below).

- Long-term ground-water monitoring would be used to monitor the movement of contaminants in the ground water and to monitor the effectiveness of natural attenuation. Monitoring would be conducted using a combination of new and existing wells and would be implemented as part of the Basewide, long-term ground-water monitoring plan. It is estimated that 30 new monitoring wells would be installed and 40 wells would be sampled and analyzed each sampling round in this area. Sampling would initially be conducted on a quarterly basis, with the potential to reduce the frequency at a later time, if warranted. Ground-water samples would be analyzed for VOCs and natural attenuation parameters.

- As described under Area 1, Alternative 2, a 50 percent cost contingency is included in this alternative to cover the potential added cost of expanding the system.

- Implementation of this alternative does not pose any unusual or extraordinary conditions. Ground-water modeling (batch-flush) was conducted for Area 2 (BG04/BG05) to determine the approximate time frame for natural attenuation to reduce the concentrations of contaminants in the ground water to levels below MCLs. Based on this modeling, it is estimated that natural attenuation would reduce chemical concentrations to levels below MCLs in approximately 14-16 years. Based on the length of time to actively remediate ground water in this area, the natural attenuation time frame is considered acceptable. However, the time frame could be shortened if more active remediation were to take place. Ground-water data in the BG04 area indicate that natural attenuation is taking place. The data from recent ground-water samples collected indicate that contaminant concentrations have been decreasing during the last four years. It is estimated that the supplemental extraction wells would be operated for 1-3 years, based on the estimated volume of ground water present in the areas proposed for supplemental ground-water removal. These estimates would be further refined in a predesign study.

Major ARARs

- The major ARARs for this alternative are the same as those for Area 1, Alternative 2.

<u>Alternative 3 - Iron Induced Dehalogenation</u>

Treatment Components

- Treatment walls composed of impermeable barrier sections and innovative, permeable, chemical treatment sections would be constructed underground to provide in situ flow-through

treatment of shallow ground water. Treatment walls would be located along the east Base boundary to contain contaminated ground water on-Base, and in the central portion of BG04 where the highest concentration of contaminants exist. The treatment walls are constructed across the flow paths of the contaminated ground water where the impermeable sections direct flow to the treatment sections. The treatment sections consist of a porous media such as sand, mixed with a catalyst, typically iron filings. Contaminants (TCE) are degraded into non-toxic chemicals as ground water flows through the wall. It is estimated that a 1,500-ft long wall would contain the majority of the contaminant plume along the Base boundary east of BG04. Similarly, a 750-ft long wall would be located along the Base boundary east of BG05. A 2,500 ft-long treatment wall would be placed in the central BG04 area.

- Once the ground-water containment and treatment systems are in place in the most contaminated areas (all of which are on-Base), the amount of off-Base contamination will be reduced to levels below MCLs through natural attenuation.

- Cottonwood, poplar, or other suitable trees would be planted in selected on-Base and/or off-Base areas to further control shallow ground water and potentially uptake some contaminants. The use of trees is for enhancement only and is not part of the primary remedy. Even without the trees, chemical concentrations off-Base would be reduced through natural attenuation.

General Components

- Institutional controls (both on-Base and off-Base) would be implemented as described under Alternative 2.

- Long-term ground-water monitoring would be implemented as described under Alternative 2.

- A 30% cost contingency is included in this alternative to expand active treatment if natural attenuation does not provide adequate protection of human health and the environment off-Base.

- Implementation of this alternative would require heavy construction equipment. The treatment walls must be keyed into the bedrock. Either sheet piling or slurry could be used for the barrier sections. Implementation requires extensive predesign studies to establish the final design parameters and locations of the treatment walls. This technology is proprietary and requires obtaining a license. The availability of vendors who install these systems is limited. The treatment sections may require replacement or regeneration during the life of the system depending on local conditions. This would be determined during predesign studies.

- It is estimated that it will take 50-100 years for contaminated ground water to move from the western extent of the plume to the Base boundary. Because of the placement of a central treatment wall and natural attenuation, the actual time for concentrations of chemicals in the ground water to be reduced below MCLs will be much less. It is estimated that it will take only 14-16 years for concentrations of chemicals in the ground water (and their associated degradation products) to be reduced to levels below MCLs by natural attenuation alone.

Major ARARs

- Ground water would be treated until MCLs are met. This system uses a passive, destructive, in situ technology and does not produce any contaminated residuals once implemented. Wastes (e.g., excavated soil, drill cuttings) generated during implementation would be disposed of in accordance with RCRA Hazardous Waste requirements, if necessary.

<u>Alternative 4 - Ground-Water Containment/Extraction and Treatment</u>

Treatment Components

- A combination of extraction wells and/or trenches would be used to contain and remove contaminated ground water in Area 2. Wells and/or trenches would be located along the Base boundary east of BG04 and BG05 to prevent off-Base movement of contaminated ground water. Some wells would also be located in the areas of highest contaminant concentrations in the central BG04 area to reduce the contaminant concentrations in ground water flowing toward the Base boundary. Based on ground-water data obtained during the BG04 Pre-Design Site Investigation, it is estimated that four extraction wells would be located in the gravel

seams east of BG04, two wells would be located east of BG05, and six wells would be located in the central BG04 area.

- Removed ground water would be treated using a combination of air strippers with carbon offgas treatment and/or activated carbon treatment units. For cost estimate purposes, it is assumed two air stripper units would be used.

- Treated ground water would be discharged as described in Alternative 2.

- On-Base ground-water containment and treatment systems will reduce source area chemical concentrations. Off-Base contamination will be reduced to levels below MCLs through natural attenuation.

- Cottonwood, poplar, or other suitable trees would be planted at selected on-Base and/or off-Base areas as described in Alternative 3.

General Components

- Institutional controls as described in Alternative 2 would be implemented as part of this alternative.

- Long-term ground water monitoring to detect potential movement of contaminants and to determine the effectiveness of the alternative would be implemented. Long-term ground-water monitoring would be the same as described in Alternative 2.

- This alternative could be implemented using standard methods and equipment that are readily available. Based on ground-water velocities in the BG04 area, and considering the influence of the extraction wells, it is estimated that it would take 25-50 years for contaminated ground water to move from the western extent of the plume to the Base boundary, and be removed and treated by the wells along the eastern Base boundary. The actual remediation time would be less if natural attenuation is factored in. Based on modeling conducted during the BG04 Pre-Design Site Investigation, it is estimated that it will take 14-16 years for concentrations of chemicals in the ground water (and their associated degradation products) to be reduced to levels below MCLs by natural attenuation. Predesign studies would be conducted to finalize design parameters and determine the number and placement of wells.

Major ARARs

- The major ARARs for this alternative are the same as those described in Alternative 2.

Alternative 5 - Dual-Phase Extraction

Treatment Components

- In situ dual-phase extraction wells would be used to remove soil gas and ground water in Area 2. This alternative is similar to Alternative 4 except for the type of wells used. Wells would be located in the same areas as described under Alternative 4. Based on vendor information, it is estimated that each dual-phase well would have a radius of influence of 100 ft. Based on that estimate, approximately 10 dual-phase wells would be located along the Base boundary east of BG04, 5 wells would be located east of BG05, and 15 wells would be located in the central BG04 area.

- Removed ground water would be treated using air strippers with carbon offgas treatment (two units estimated). Removed air would be treated using vapor-phase carbon adsorption units (two units estimated).

- Treated ground water would be discharged as described in Alternative 2.

- On-Base ground-water containment and treatment systems will reduce source area chemical concentrations. Off-Base contamination will be reduced to levels below MCLs through natural attenuation.

- Cottonwood, poplar, or other suitable trees would be planted in selected on-Base and/or off-Base areas as described in Alternative 3.

General Components

- Institutional controls as described in Alternative 2 would be implemented as part of this alternative.

- Long-term ground water monitoring to detect potential movement of contaminants and to determine the effectiveness of the alternative would be implemented. Long-term ground-water monitoring would be the same as described in Alternative 2.

- This alternative could be implemented using standard methods and equipment that are readily available. Low permeability soils typical of EAFB may reduce effectiveness of this alternative. Additional pilot tests may be required to verify the implementability of this alternative. Based on ground-water velocities in the BG04 area, and considering the influence of the dual-phase extraction wells, it is estimated that it will take 20-40 years for contaminated ground water to move from the western extent of the plume to the Base boundary, and be removed and treated by the wells along the eastern Base boundary. The actual time would be somewhat less if natural attenuation is factored in. Based on modeling conducted during the BG04 Pre-Design Site Investigation, it is estimated that it will take 14-16 years for concentrations of chemicals in the ground water (and their associated degradation products) to be reduced to levels below MCLs by natural attenuation.

Major ARARs

- The major ground-water ARARs for this alternative are the same as those described in Alternative 2. Emissions from vapor-phase carbon treatment units would meet requirements of the Clean Air Act (CAA) and state air quality requirements. Wastes (e.g., drill cuttings) generated during implementation would be disposed of in accordance with RCRA Hazardous Waste requirements, if necessary.

2.8 SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES

The analysis of alternatives coupled with the use of the presumptive remedy provides a narrower range of feasible remedial actions for ground water at OU-11.

The RAOs for OU-11 are as follows:

- Prevent future human exposure to on-Base ground water with contaminants exceeding State of South Dakota Ground-Water Quality Standards and Federal MCLs.
- Prevent additional ground water containing contaminants above State of South Dakota Ground-Water Quality Standards and Federal MCLs from moving off-Base.
- Prevent human exposure to off-Base ground water with contaminants exceeding State of South Dakota Ground-Water Quality Standards and Federal MCLs.

The area of attainment is defined as the area which will achieve the remedial action objectives after remediation is completed. The physically or geographically distinct areas of OU-11 make it feasible to divide the OU into separate areas for purposes of evaluating attainment status and determining appropriate response actions. The areas of attainment for OU-11 are discussed below.

Area 1 (South Docks)

As described previously, Area 1 includes the South Docks and the northern part of OU-9. Ground water in OU-9 was initially investigated separately during the OU-9 RI. Because of the proximity to the South Docks area and the potential for commingled plumes in these areas, development of ground-water remediation alternatives was deferred to OU-11. The area of attainment is illustrated in Figure 3.

Area 2 (BG04/BG05)

Area 2 includes the on-Base areas surrounding monitoring wells BG04 and BG05 and the off-Base areas to the east. The area of attainment for the on-Base areas of Area 2 are illustrated on Figure 4 (BG04 area) and Figure 5 (BG05 area). The off-Base area of attainment for Area 2 is illustrated on Figure 6.

Pursuant to Section 300.430(e)(9)(iii) of the EPA's revised National Oil and Hazardous Substances Pollution Contingency Plan (NCP), the remedial action to be implemented should be selected based upon consideration of nine evaluation criteria. These criteria are as follows:

Threshold Criteria

1. Overall protection of human health and environment.
2. Compliance with applicable or relevant and appropriate requirements (ARARs).

Primary Balancing Criteria

3. Long-term effectiveness and permanence.
4. Reduction of toxicity, mobility, or volume of contamination.
5. Short-term effectiveness.
6. Implementability.
7. Cost.

Modifying Criteria

8. State acceptance.
9. Community acceptance.

The following sections provide a brief review and comparison of the remedial alternatives according to EPA's evaluation criteria.

2.8.1 Overall Protection Of Human Health And The Environment

The assessment of this criterion considers how the alternatives achieve and maintain protection of human health and the environment.

Area 1

Alternative 1 does nothing to reduce risk levels associated with consumption and contact with shallow ground water. Alternative 2 reduces the potential for exposure to untreated shallow ground water through the use of natural attenuation with supplemental source removal and treatment, and institutional controls. Alternative 2 includes a contingency because it relies on natural attenuation. Natural attenuation will be further evaluated during preliminary ground-water monitoring to determine if contaminants in the ground water will be reduced to levels below regulatory standards prior to movement off-Base. Alternative 3 provides protection of human health and the environment by actively removing and treating contaminated ground water and implementing institutional controls to prevent use of untreated ground water until it meets MCLs. Alternative 4 uses a combination of active treatment (AAS/SVE) and natural attenuation to protect human health and the environment. As in Alternative 2, Alternative 4 requires a contingency because of the partial reliance on natural attenuation. Alternative 5 is similar to Alternative 3 in that it removes and treats ground water; however, this alternative relies on interception of contaminated ground water as it flows to the boundary of the contaminated area rather than placing wells/trenches within the plume as in Alternative 3. All alternatives use institutional controls to prevent use of contaminated ground water.

Area 2

Alternative 1 does nothing to reduce risk levels associated with consumption and contact with shallow ground water. Alternative 2 reduces the potential for exposure to untreated shallow ground water through the use of natural attenuation with supplemental source removal and treatment, and institutional controls including providing alternate sources of water to off-Base residents whose water supplies have been adversely impacted by the Base. Alternative 2 includes a contingency because it relies on natural attenuation. Natural attenuation will be further evaluated during preliminary ground-water monitoring to determine if contaminants in the ground water will be reduced to levels below MCLs in a reasonable time frame. Alternative 3 is protective of human health and the environment by containing and passively treating contaminated ground water as it flows through treatment walls that destroy the contaminants, and the use of institutional controls to prevent use of untreated ground water until it meets MCLs. Alternative 4 uses wells and/or trenches and treatment systems to prevent ground water with chemical concentrations above MCLs and risk-based concentrations from moving off-Base and to remove and actively treat contaminated ground water until it meets MCLs. Alternative 5 is similar to Alternative 4 in that it removes and treats ground water; however, this alternative uses dual-phase extraction wells to protect human health and the environment. Alternatives 3, 4, and 5 rely on natural attenuation to reduce low concentrations of contaminants off-Base. A long-term monitoring program will be used to determine long-term protection to human health and the environment and to determine the need for additional remedial measures off-Base. All alternatives incorporate institutional controls to help protect human health and the environment.

2.8.2 Compliance With ARARs

Alternatives are assessed under this criterion in terms of compliance with ARARs. Applicable requirements include cleanup standards, standards of control and other substantive environmental protection requirements, criteria or limitations promulgated under federal or state laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location or other circumstances at a CERCLA site.

Relevant and appropriate requirements address problems or situations sufficiently similar to those encountered at a CERCLA site that their use is well suited to the environmental and technical factors at a particular site. The determination of "relevant and appropriate" emphasizes the similarity and appropriateness of the requirement to a site. ARARs are grouped into these three categories:

- Chemical-Specific ARARs are health or risk-based numerical values or methodologies which, when applied to site-specific conditions, result in establishment of the amount or concentration that may be found in, or discharged to, the environment.

- Location-Specific ARARs restrict the concentration of hazardous substances or the conduct of activities solely because they are in specific locations such as flood plains, wetlands, historic places, and sensitive ecosystems or habitats.

- Action-Specific ARARs are usually technology or activity-based requirements or limitations on actions taken with respect to hazardous wastes.

A summary evaluation of Federal and State ARARs pertinent tn this remedial action is provided in Table 5 at the end of Section 2.0 and a narrative discussion in compliance with ARARs is provided below for the alternatives considered.

Area 1

Alternative 1 does not meet the chemical-specific ARARs for ground water. Alternative 2 will meet chemical-specific ARARs only if site conditions are favorable for natural attenuation (this will be determined during the predesign study, and ground-water monitoring). Alternatives 3 and 5 would meet the chemical-specific ARARs for ground water by actively treating ground water with chemical concentrations above MCLs. Alternative 4 would likely meet chemical-specific ARARs for the areas actively treated; however, the alternative also relies on natural attenuation as does Alternative 2. Ground water contaminated above MCLs would be contained on-Base under Alternatives 3 and 5 and may be contained on-Base under Alternatives 2 and 4, depending on the effectiveness of natural attenuation. Alternatives 2, 3, 4, and 5 would meet location and action specific ARARs identified in Table 5.

Area 2

Alternative 1 does not meet the chemical-specific ARARs for ground water. Alternative 2 (on-Base and off-Base) and Alternatives 3, 4, and 5 (off-Base) will meet chemical-specific ARARs only if site conditions are favorable for natural attenuation (this will be determined during the predesign study, and ground-water monitoring). Alternatives 3, 4 and 5 would meet the chemical-specific ARARs for ground water by actively treating (pump and treat) on-Base ground water with chemical concentrations above MCLs. Natural attenuation will reduce contaminant concentrations off-Base to levels below MCLs over time. Further off-Base movement of ground water contaminated above regulatory standards would be reduced and eventually eliminated or contained under Alternative 3, 4, and 5, allowing natural attenuation to proceed at a faster rate. If natural attenuation proves to be ineffective in a reasonable time frame, additional remedial measures will be conducted so that ground water will meet MCLs. Alternatives 2, 3, 4, and 5 would meet location and action specific ARARs identified in Table 5.

2.8.3 Long-term Effectiveness And Permanence

The assessment of this criterion considers the long-term effectiveness of alternatives in maintaining protection of human health and the environment after response action objectives have been met.

Area 1

Alternative 1 would not provide long-term effectiveness in reducing the potential for movement of VOCs in ground water. Alternative 2 uses a combination of natural attenuation, extraction and treatment, and institutional controls to reduce the potential for movement of solvents and other contaminants in ground water and prevents the use of untreated ground water until it meets MCLs. The long-term effectiveness of natural attenuation will be evaluated during ground-water monitoring. Alternatives 3 and 4 provide

long-term effectiveness in reducing the potential for movement of chemicals of concern in ground water by treating ground water and using institutional controls to prevent use of untreated ground water; however, Alternative 4 also relies partly or natural attenuation. Alternative 5 provides long-term effectiveness using a combination of containment and institutional controls; however, Alternative 5 does not provide long-term effectiveness to the extent provided under Alternatives 3 and 4 due to the reduced amount of extraction systems. Alternatives 2, 3, 4, and 5 use long-term monitoring to detect potential offsite movement of ground water above MCLs. Because of the uncertainties of natural attenuation associated with Alternative 4, Alternative 3 would provide the greatest long-term effectiveness and permanence.

Area 2

Alternative 1 would not provide long-term effectiveness in reducing the potential for movement of VOCs in ground water. Alternative 2 uses natural attenuation and institutional controls to reduce the concentration of TCE in ground water and prevents the use of untreated ground water until it meets MCLs. The long-term effectiveness of natural attenuation is not known at this time but will be evaluated in the early stages of implementation of this alternative. Alternatives 3, 4, and 5 offer equal long-term effectiveness in reducing the potential for movement of chemicals in ground water by containing and treating ground water on-Base and using institutional controls to prevent use of untreated ground water above MCLs. However, Alternative 4 may be the most effective in the long term due to simpler operating requirements. Alternative 3 and 5 require the use of technologies and equipment that are not as widely used or accepted. Alternatives 2, 3, 4, and 5 use long-term monitoring to monitor movement of contaminated ground water and the potential impact to off-Base water supplies.

2.8.4 Reduction Of Toxicity, Mobility, Or Volume Through Treatment

The assessment of this criterion considers the anticipated performance of specific treatment technologies an alternative may employ.

Area 1

Alternative 1 does not reduce toxicity, mobility, or volume of contaminated ground water, except through natural processes and has no provision for monitoring. Alternative 2 uses natural attenuation to reduce the toxicity and volume of contaminated ground water, and supplemental extraction and treatment in the areas with the highest concentrations of contaminants, to reduce the toxicity, mobility, and volume of affected ground water. Alternatives 3 and 5 reduce the toxicity, volume, and mobility of contaminated ground water through extraction/treatment and containment (with extraction and treatment at the containment points), respectively. Alternative 4 reduces the volume and toxicity of contaminated ground water through treatment and natural attenuation; however, in some cases AAS has been shown to increase the movement of contaminated ground water. Due to the extent of the extraction systems, Alternative 3 will be most reliable and efficient in reducing the toxicity, mobility, and volume of contaminants in ground water.

Area 2

Alternative 1 does not reduce toxicity, mobility, or volume of contaminated ground water, except through natural processes and there is no provision for monitoring. Alternative 2 relies on natural attenuation to reduce the toxicity and volume of contaminated ground water and supplemental extraction and treatment to reduce the toxicity, mobility, and volume of affected ground water with the highest concentrations of contaminants. Alternatives 2, 3, 4, and 5 rely on natural attenuation to reduce the volume of contaminants in off-Base areas. However, if natural attenuation does not reduce contaminant concentrations, the cleanup components under Alternative 4 would be the easiest to implement in off-Base areas. Alternatives 4, and 5 reduce the toxicity, volume, and mobility of contaminated ground water through extraction and treatment of affected ground water on-Base. Alternative 3 reduces the volume and toxicity of contaminated ground water through treatment as it passes through a treatment wall. Under Alternatives 3, 4, and 5, toxicity and volume of affected ground water off-Base is reduced through natural attenuation. Alternative 4 would be the most reliable in reducing toxicity, mobility, and volume because the alternative relies on proven technologies in comparison to Alternatives 3 and 5.

2.8.5 Short-Term Effectiveness

The assessment of this criterion considers the effectiveness of alternatives in maintaining protection of human health and the environment during the construction of a remedy until response action objectives have been met.

Area 1

It is not anticipated that the proposed alternatives would significantly impact worker or community health and safety during the implementation period. Alternative 2, 3, 4, and 5 may impact worker health and safety through dust emissions and exposure to chemicals in the soil and ground water during the initial construction phase. PPE will be used to mitigate potential risks to workers during implementation of the remedial alternative. If necessary, VOCs emitted from the air stripper will be treated prior to release. Alternative 3 would most readily address risk in the short term due to the ease of implementation and the extent of extraction and treatment as compared to Alternative 4. Alternative 5 only involves containment of the contamination, thereby requiring a longer remediation time frame.

Area 2

It is not anticipated that the proposed alternatives would significantly impact the surrounding people or the environment or worker health and safety during the implementation period. Alternatives 2, 3, 4, and 5 may impact worker health and safety through dust emissions and exposure to chemicals in the soil and ground water during the initial construction phase. PPE will be used to mitigate potential risks to workers during implementation of the remedial alternative. If necessary, VOCs emitted from the air stripper will be treated prior to release. Short-term risk is addressed equally under Alternatives 2, 3, 4, and 5 by implementation of the alternate water supply. Alternative 2 would not contain contaminated ground water on-Base, which would not address short-term risk as adequately as Alternatives 3, 4, and 5.

2.8.6 Implementability

The assessment of this criterion considers the administrative and technical feasibility of implementing the alternatives and the availability of necessary goods and services for implementation of the response action.

Area 1

There is nothing to implement under Alternative 1. The remaining alternatives require no special or unique activities and could be implemented with readily available equipment, materials, and methods. Alternatives 2, 3, 4, and 5 would require a predesign study prior to implementation to determine effectiveness and final design parameters. Alternative 2 may not be as implementable as the other alternatives based on the ability of the natural processes to remediate the ground-water contamination in a reasonable time frame. The need for many AAS points and SVE wells makes Alternative 4 harder to implement than Alternatives 3 and 5. At Area 1, the largest ground-water extraction systems will be the most difficult to implement because of ongoing Base activities (i.e., operation of the flightline). Although Alternative 3 is implementable, Alternative 5 may be the easiest to implement due to the minimal amount of extraction systems needed.

Area 2

Alternative 1 requires no implementation. The remaining alternatives require no special or unique activities and could be implemented with readily available equipment, materials, and methods. Alternative 3 may require deep trenching methods. Alternatives 2, 3, 4, and 5 would require a predesign study prior to implementation to determine final design parameters. Alternatives 3 and 5 would require more detailed predesign studies than Alternative 4. It is expected that Alternative 3 would be the most difficult to implement due to the depth of trench needed and characteristics of underlying geology. If natural attenuation does not reduce contaminant concentrations, the cleanup components under Alternative 4 would be the easiest to implement in off-Base areas. Because Alternative 4 uses proven technologies with known results, it would be the most implementable alternative.

2.8.7 Cost

The assessment of this criterion considers the capital and operation and maintenance (O&M) costs associated with each of the alternatives. Costs were developed using the Remedial Action Cost Engineering and Requirements System (RACER), Means Building Cost Index, vendor estimates, and contractor experience. Alternatives are evaluated for cost in terms of both capital costs and long-term O&M costs necessary to ensure continued effectiveness of the alternatives. Capital costs include the sum of the direct capital costs (materials and labor) and indirect capital costs (engineering, licenses, permits). Long-term O&M costs include labor, materials, energy, equipment replacement, disposal, and sampling necessary to ensure the future effectiveness of the alternative.

The objective of the cost analysis is to evaluate the alternatives based on the ability to protect human health and the environment for additional costs that may be incurred. Cost varies between the alternatives as a result of differences in the amount of materials and the level of effort required for each alternative. The least costly alternative for Area 1 and Area 2 is the No Action alternative.

Area 1

For Area 1, the least costly alternative which includes a remedial action is Alternative 2. Alternative 3 is the next more costly alternative. The most costly alternative is Alternative 4, which is more than twice the cost of Alternative 3. Alternative 5, Containment, is more costly than Alternative 3, Ground-Water Extraction and Treatment with Containment. Alternative 5 requires a longer remediation time frame which accounts for most of the cost difference as compared to Alternative 3. Even though Alternative 3 is not the least costly alternative, the added capital costs versus the benefit gained, as compared to the other alternatives, indicate that Alternative 3 is the most cost effective alternative.

Area 2

For Area 2, the least costly of the alternatives that include remedial actions is Alternative 2. Alternative 4 is the next more costly alternative. The most costly alternative is Alternative 3 which is more than twice the cost of Alternative 4. Long-term monitoring costs for remedies that include remedial actions are similar for each alternative. With added capital costs, Alternative 4, Ground-Water Containment/Extraction and Treatment, would be the most cost effective alternative.

A summary of the costs for each alternative is as follows:

Area 1

Alternative 1 (No Action)

Total Capital Costs	$0
30-Year Present Value for Annual Costs Annual Cost = $0 Years = 30 Discount Rate = 5%	$0
TOTAL 30-Year Present Value	$0

Alternative 2 (Natural Attenuation w/ Supplemental Source Removal)

Total Capital Costs	$1,224,000
30-Year Present Value for Annual Costs Annual Cost - Years 1-3 = $243,000 Annual Cost - Years 4-20 = $70,000 Years = 30 Discount Rate = 5%	$1,344,000
TOTAL 30-Year Present Value	$2,568,000

Alternative 3 (Ground-Water Extraction and Treatment w/Containment)

Total Capital Costs	$2,780,000
30-Year Present Value for Annual Costs Annual Cost - Years 1-10 = $254,400 Years = 30 Discount Rate = 5%	$1,964,000
TOTAL 30-Year Present Value	$4,744,000

Alternative 4 (AAS/SVE)

Total Capital Costs	$8,588,000
30-Year Present Value for Annual Costs Annual Cost - Years 1-5 = $509,000 Annual Cost - Years 6-20 = $125,000 Years = 30 Discount Rate = 5%	$3,224,000
TOTAL 30-Year Present Value	$11,812,000

Alternative 5 (Containment)

Total Capital Costs	$2,095,000
30-Year Present Value for Annual Costs Annual Cost - Years 1-20 = $262,400 Years = 30 Discount Rate = 5%	$3,270,000
TOTAL 30-Year Present Value	$5,365,000

Area 2

Alternative 1 (No Action)

Total Capital Costs	$0
30-Year Present Value for Annual Costs Annual Cost = $0 Years = 30 Discount Rate = 5%	$0
TOTAL 30-Year Present Value	$0

Alternative 2 (Natural Attenuation w/ Supplemental Source Removal)

Total Capital Costs	$802,000
30-Year Present Value for Annual Costs Annual Cost - Years 1-3 = $139,500 Annual Cost - Years 4-16 = $89,500 Years = 30 Discount Rate = 5%	$1,106,000
TOTAL 30-Year Present Value	$1,908,000

Alternative 3 (Iron Induced Dehalogenation)

Total Capital Costs	$4,941,000
30-Year Present Value for Annual Costs Annual Cost - Years 1-16 = $136,000 Years = 30 Discount Rate = 5%	$1,474,000
TOTAL 30-Year Present Value	$6,415,000

Alternative 4 (Ground-Water Containment/Extraction and Treatment)

Total Capital Costs	$1,124,000
30-Year Present Value for Annual Costs Annual Cost - Years 1-3 = $188,500 Annual Cost - Years 4-16 = S144,000 Years = 30 Discount Rate = 5%	$1,682,000
TOTAL 30-Year Present Value	$2,806,000

Alternative 5 (Dual-Phase Extraction)

Total Capital Costs	$1,695,000
30-Year Present Value for Annual Costs Annual Cost - Years 1-3 = $184,000 Annual Cost - Years 4-16 = $137,000 Years = 30 Discount Rate = 5%	$1,611,000
TOTAL 30-Year Present Value	$3,306,000
OU-8 Compliance Monitoring	
OU-8 Compliance Monitoring(a)	
Total Capital Costs	25,000
Total Annual Sampling & Analysis Costs	21,000
TOTAL 1 YEAR COST	$46,000

NOTES:(a) OU-8 compliance is not part of Area 1 or Area 2 alternatives. Compliance monitoring at OU-8 will be conducted regardless of the alternative.

2.8.8 State Acceptance

The assessment of this criterion considered the State's preferences for or concerns about the alternatives.

The State concurs with the selected remedy. The State provided comments on the remedial investigation, feasibility study, and Proposed Plan. In accordance with the requirements of the NCP, the State of South Dakota was also provided the opportunity to review and comment on the ROD. As a result of that review and after incorporating adequate responses to the comments into the respective documents, the State concurred with the remedy.

2.8.9 Community Acceptance

Comments offered by the public were used to assess the community acceptance of the proposed alternative. The community expressed their concerns about the selected remedy during the public comment period and during the public meeting. There were no written comments received during the public comment period. Questions were posed to the Base during the public meeting. In general, public comments were directed at specific components of the remedy, rather than the remedy itself. There were no objections to the selected remedial alternative. Public questions about the remedy posed during the public meeting appeared to be satisfactorily addressed during the meeting. The questions and concerns of the community are discussed in detail in the Responsiveness Summary, which is Appendix C of the ROD.

2.9 SELECTED ALTERNATIVE

Based on the requirements of CERCLA, comparative analysis using the nine criteria, public comments, and in consultation with EPA and the State, the Air Force has determined that the selected alternative for Area 1 is Alternative 3, Ground-Water Extraction and Treatment with Containment; and for Area 2 is Alternative 4, Ground-Water Containment/Extraction and Treatment. These alternatives include institutional controls in conjunction with ground-water containment and treatment of extracted ground

water to reduce potential risk. Five-year reviews of the remedy will be required because potential contaminants will remain at OU-11 above health-based levels following completion of the installation ground-water extraction systems, and the use of natural attenuation in the off-Base BG04/BG05 area.

Major components of Alternative 3 for Area 1 are:

- Removal and containment of ground water containing contaminants at concentrations above MCLs.
- Ground-water treatment and discharge.
- Institutional controls and long-term monitoring.

Ground-Water Removal and Containment

A pre-design study mutually agreeable to the Air Force, EPA, and the State of South Dakota would be conducted to determine the final number and location of ground-water extraction wells/trenches required to remove and/or contain ground water. Based on the results of the predesign study, extraction wells and/or trenches will be located to remove ground water contaminated above MCLs. Some wells may be located as containment wells along the perimeter of the area, to prevent offsite movement of ground water containing contaminants above MCLs.

Ground-Water Treatment and Discharge

Removed ground water will be treated using a combination of air strippers and/or activated carbon ground-water treatment units. Air strippers will be equipped with off gas treatment, if necessary. Treated ground water will be discharged to the Base WWTP, surface discharge, or be injected back into the aquifer based on the results of predesign studies.

Institutional Controls and Long-Term Monitoring

Institutional controls will be implemented to prevent the use and consumption of untreated ground water. These controls will include: (1) issuing a continuing order (by the Installation Commander) to restrict or place limitations on the installation of any new ground-water wells; (2) filing a notice in environmental and real estate records at the Base or Installation, detailing the restrictions of the continuing order and ground-water well restrictions; and (3) compliance with the provisions of CERCLA Section 120(h)(3) or other applicable statutory requirements in the event of property transfer.

A long-term monitoring program will be developed and implemented during remedial action and is subject to approval of both EPA and SDDENR. Contaminant concentrations in the ground water will be monitored to evaluate the effectiveness of the remediation system and to determine if contaminants in the ground water are moving offsite. If it is determined that contaminants in the ground water are moving offsite, appropriate action will be taken to remedy this situation. Continued analysis and monitoring of the ground-water remediation system will be conducted to determine if the remediation system is approaching an asymptotic level due to physical limitations of the site, or the benefits of the remedial action no longer justify the long-term operation of the system. Remediation goals and the remedial alternative will be re-evaluated at that time. Long-term monitoring will continue until State of South Dakota Ground-Water Quality Standards and Federal MCLs are met.

This alternative will meet the remedial action objectives and reduce the potential risk for OU-11 by preventing future exposure to contaminants in the ground water.

The major components of Alternative 4 for Area 2 are:

- Ground-water removal along the northeast Base boundary and at areas with high contaminant concentrations on-Base.
- Ground-water treatment and discharge.
- Natural attenuation of off-Base ground water.
- Alternative water supply to off-Base residents affected by contamination coming from the Base.
- Additional investigation to determine the eastern extent of off-Base ground-water contamination

- Institutional controls and long-term monitoring.

Ground-Water Removal

A pre-design study would be conducted to determine the final number and location of ground-water extraction wells/trenches required to contain contaminated ground water on-Base and remove ground water in the areas of highest contaminant concentrations on-Base. Generally, wells will be located on-Base in the BG04 area and the BG05 area.

Ground-Water Treatment and Discharge

Removed ground water will be treated using a combination of air strippers and/or activated carbon ground-water treatment units. Air strippers would be equipped with off gas treatment, if necessary. Treated ground water will be discharged to the Base WWTP, a surface water drainage, or be injected back into the aquifer based on the results of predesign studies.

Natural Attenuation

Contaminants in off-Base ground water will be reduced to concentrations below MCLs through natural attenuation. Once the ground-water containment and treatment systems are installed in the most contaminated areas, all of which are on-Base, the amount of off-Base contamination will also be reduced to levels below MCLs. The physical and chemical characteristics of the off-Base soil and ground water are capable of dispersing and reducing the relatively low concentrations of ground-water contamination.

In addition, cottonwood, poplar, or other suitable trees will be planted at selected locations on-Base and/or off-Base as an innovative way to further control shallow ground-water movement. Cottonwood and poplar trees are fast growing and are known to use significant quantities of water. There is also evidence to suggest that trees take in organic contaminants with the water, reducing contaminant concentrations. The quantity and location of trees will be determined during the remedial design and will be done in a manner not to effect the availability of water in downgradient drinking water wells. The contaminants do not accumulate in the trees, but are either broken down through the respiration process or emitted to the atmosphere. These emissions would be negligible due to the already low amounts of contaminants in the ground water. The use of trees is experimental and is solely to enhance natural attenuation. If the trees do not function as planned, reduction of chemicals in the ground water off-Base will still take place through other natural attenuation processes.

If, during subsequent reviews, sampling results indicate that contaminant concentrations in the ground water are not being reduced through natural attenuation prior to movement off-Base or at the predicted rate to be protective of human health and the environment, the use of additional remedial activities will be evaluated and conducted. The extent of additional remediation will be dependent on the amount of remaining contamination in the ground water. The pump and treat portion of this alternative could be expanded to treat additional areas of contaminated ground water both on-Base and off-Base as necessary.

Alternative Water Supply for Off-Base Resident

The Air Force will provide a clean water supply to residents whose drinking water contains contaminants at concentrations above State of South Dakota or Federal MCLs due to movement of contaminants beyond the Base boundary. EAFB currently has a proactive program in which they will provide, at no cost, an alternative potable water supply to such residents. This program is administered on a case-by-case basis and consists of agreements with individual landowners. Enough water would be supplied to the landowners to carry out normal domestic activities, which includes drinking, bathing, cooking, lawn and garden watering, and other residential outdoor activities. The program can be used to fulfill the alternative water supply requirement and will be continued (on a case-by-case basis) until contaminant concentrations are below State of South Dakota or Federal MCLs.

Additional Investigation

Based on predesign investigations conducted in the BG04 area, there may be additional off-Base sources contributing to ground-water contamination off-Base. An additional investigation will be conducted to determine the extent of contamination moving beyond the Base boundary. This will clarify the extent of Air Force's liability under CERCLA for remediation of the off-Base areas. The Air Force will address all ground-water contamination coming from the Base, including any new areas discovered through the additional investigation.

Institutional Controls and Long-Term Monitoring

Institutional controls similar to those described under Alternative 3 for Area 1 will be implemented. In addition, a monitoring program will be implemented to monitor the effectiveness of natural attenuation in providing protection to human health and the environment.

2.10 STATUTORY DETERMINATIONS

The selected remedies meet the statutory requirements of CERCLA as amended by SARA and the NCP. These requirements include protection of human health and the environment, compliance with ARARs, cost effectiveness, and utilization of permanent solutions and alternative treatment technologies to the extent practicable. Containment, by definition, does not attempt to reduce the toxicity or volume of potentially hazardous materials; rather, it reduces the likelihood of exposure to contaminants by preventing the movement of materials beyond the boundaries of the site. The selected remedies represent the best balance of tradeoffs among the alternatives considered, with respect to pertinent criteria.

The manner in which the selected remedies meets each of the requirements is discussed in the sections below.

2.10.1 Protection of Human Health and the Environment

Area 1

The selected remedy addresses health and environmental issues that were identified in the OU-11 RI report. Specifically, the ground-water extraction and treatment alternative:

- Eliminates exposure to contaminated ground water by removing it from the ground and treating it to meet MCLs.
- Reduces risk by reducing the concentration of contaminants in the ground water.
- Provides onsite containment of contaminated ground water.
- Prevents the use of untreated ground water.
- Provides for long-term monitoring of ground water to identify potential future risks associated with OU-11.

Area 2

The selected remedy addresses health and environmental issues that were identified in the OU-11 RI report. Specifically, the ground-water extraction and treatment alternative:

- Reduces exposure to contaminated ground water by containing it on-Base.
- Reduces risk by reducing the concentration of contaminants in the ground water to levels below MCLs.
- Prevents the use of untreated ground water.
- Provides for long-term monitoring of ground water to identify potential future risks associated with OU-11 and monitor the effectiveness of natural attenuation.

2.10.2 Compliance with ARARs

Alternative 3 for Area 1 and Alternative 4 for Area 2 both will meet Safe Drinking Water Act MCLs and State Ground Water Quality Standards. If necessary, offgas emissions from air strippers would be treated to meet requirements of the Clean Air Act (CAA) and state air quality requirements. Ground water would be further treated, if necessary, to meet Clean Water Act (CWA) requirements for surface water discharges of treated ground water. Wastes (e.g., drill cuttings) generated during implementation would be disposed of in accordance with RCRA Hazardous Waste requirements, if necessary. Additional information about ARAR compliance is contained in Section 2.8.2.

2.10.3 Cost Effectiveness

The selected remedies are cost effective because they have been determined to provide overall effectiveness in reducing human health risks relative to its costs.

Area 1

The net present worth of Alternative 3 for Area 1 is $4,744,000. The estimated costs of the selected remedy are within an order of magnitude of (less than two times) the costs associated with natural attenuation alternative, and yet the selected remedy provides active treatment in a much shorter time frame, reducing the potential for offsite movement of contaminants. The selected remedy is less costly than the remaining alternatives for Area 1.

Area 2

The net present worth of Alternative 4 for Area 2 is $2,806,000. The estimated costs of the selected remedy are within an order of magnitude of (less than two times) the costs associated with Alternative 2, which does not fully meet remedial action objectives because it does not provide containment of contaminated ground water. The selected remedy is less costly than the remaining alternatives for Area 2.

2.10.4 Utilization of Permanent Solutions and Alternative Treatment Technologies to the Extent Possible

EPA has established that ground-water extraction and treatment has proven effective in remediating contaminated ground water. The selected remedies for Area 1 and Area 2 utilize permanent solutions and treatment technologies to the maximum extent practicable. Alternative treatment technologies, including natural attenuation and phytoremediation, were also evaluated and incorporated into the selected remedies for Area 1 and Area 2. The selected remedies provide the best tradeoff among alternatives relative to the five primary balancing criteria.

Area 1

Alternative 3, the selected alternative, provides a permanent solution to exposure to contaminated ground-water, by removing and treating contaminated ground water and preventing unauthorized use of untreated ground water until MCLs have been met. A long-term ground-water monitoring system will be implemented to detect potential movement of chemicals from the area of attainment.

Because Alternative 3 utilizes proven technologies and is more reliable for treating contaminated ground water as compared to the other alternative, it will provide the greatest efficiency in reducing contaminant toxicity, mobility, and volume through treatment. Because the selected alternative is less technically complex as compared to Alternative 4, and provides for more active remediation as compared to Alternatives 5 and 2, Alternative 3 will address risk in the shortest time frame. Although Alternative 3 is not the easiest alternative to implement, long-term effectiveness and cost effectiveness out weigh any difficulties that may be encountered during implementation of the remedy. The relatively small increase in capital costs for Alternative 3, as compared to the other alternatives, greatly increases the cost effectiveness of the remedy. Alternative 3 was chosen because it can address risk to human health in a reasonable time frame, it is a proven technology in treating contaminated ground water, and it is the most cost effective remedy as compared to the other alternatives.

The State accepts the use of the selected alternative. The State has been involved with the remedial investigation and remedy selection process. Concerns regarding the development of the alternatives were identified by the State and were adequately addressed.

Anticipated community concerns were addressed during the development of alternatives. During the public comment period, the community did not identify any additional concerns for the selected remedy at Area 1.

Area 2

Alternative 4, the selected alternative, provides a permanent solution to exposure to contaminated ground-water, by removing and treating contaminated ground water on-Base and preventing unauthorized use of untreated ground water until MCLs have been met. A long-term ground-water monitoring system will be implemented to detect potential movement of chemicals from the area of attainment. Once the areas of ground water with the highest concentrations of contaminants are contained and treated on-Base, natural attenuation will reduce lower concentrations of contaminated ground water off-Base to levels below MCLs. Alternative water supplies will be provided to off-Base residents to reduce risk until the ground water quality meets MCLs.

Alternative 4 is the most effective in the long term due to simpler operating requirements of the remedial action as compared to other alternatives. Natural attenuation is relied upon only in areas where contaminant concentrations are low, greatly increasing the reliability of the remedy. Alterative 4 uses the most proven technologies as compared to the other alternative. This increases the reliability in reducing contaminant toxicity, mobility, and volume through treatment. Alternative 4 includes measures to address short-term risk to nearby residents. Alternative 4 requires simple operating procedures which will allow for it to be implemented most efficiently as compared to other alternatives. The ground water treatment systems could be easily implemented in off-Base areas if natural attenuation is not remediating the ground water in a reasonable time frame. Alternative 4 is the most cost effective alternative, particularly as compared to Alternatives 3 and 5. Although Alternative 4 does not use the most innovative technologies as compared to other alternatives evaluated, it will provide for reliable ground-water treatment, it includes measures to address short-term risk, and it is the most cost effective alternative.

The State accepts the use of the selected alternative. The State has been involved with the remedial investigation and remedy selection process. Concerns regarding the development of the alternatives were identified by the State and were adequately addressed.

The community did not object to the use of Alternative 4 for Area 2, but individuals had concerns with the implementation of the remedy. These concerns were adequately addressed by clarifications about the performance of the remedy. The selected alternative provides for enough flexibility to address any additional concerns during the long-term operation and maintenance of the remedial action.

A five-year review of the selected remedy will be performed due to the time frame needed to meet cleanup goals and the uncertainty of natural attenuation. The review will be conducted no less often than every five years after the signing of the ROD to ensure the remedy continues to provide adequate protection of human health and the environment.

2.10.5 Preference for Treatment as a Principal Element

The selected remedies for Areas 1 and 2 both provide treatment of contaminated ground water as their principal element. The selected remedy for Area 2 utilizes natural attenuation in the off-Base areas. This is justified for the following reasons:

- The sources of the highest concentrations of contaminants in the ground water will be cut off from off-Base ground water, allowing natural attenuation to proceed at a faster rate.
- The concentrations of chemicals in the ground water off-Base are relatively low.
- Alternative water supplies are being provided to residents whose water supplies have been impacted by the Base.

2.11 DOCUMENTATION OF SIGNIFICANT CHANGES

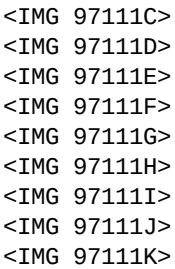
The Proposed Plan for Area 1 indicated the selected remedy for Area 1 included remediation of ground water in the North Docks and the area surrounding Building 102 located in the eastern part of OU-9. Review of the ground-water data from these areas indicate that the contamination in the ground water is the result of petroleum product releases. Only isolated occurrences of solvents were detected at low concentrations. Based on this information, remediation of the ground water in these areas will be addressed by the Air Force through the State of South Dakota Petroleum Release Program and not under CERCLA. Therefore, the selected remedy for Area 1 no longer includes remediation of ground water in the North Docks area or the area around Building 102. The Air Force will continue to clean up these sites under the State program in an efficient, expedient manner similar to other areas directed for cleanup through the OU-11 ROD.

3.0 LIST OF ACRONYMS AND ABBREVIATIONS

ACC:	Air Combat Command
AF:	Air Force
AFB:	Air Force Base
ARARs:	Applicable or Relevant and Appropriate Requirements
CERCLA:	Comprehensive Environmental Response, Compensation and Liability Act
COC:	Chemical of Concern
DCE:	Dichloroethene
EOD:	Explosive Ordnance Disposal
EAFB:	Ellsworth Air Force Base
EPA:	Environmental Protection Agency
FFA:	Federal Facilities Agreement
HHRA:	Human Health Risk Assessment
HI:	Hazard Index
HQ:	Hazard Quotient
IN SITU:	In the original place
IRP:	Installation Restoration Program
JP-4:	Jet Propulsion Fuel Number Four; contains both kerosene and gasoline fractions.
MCL:	Maximum Contaminant Level
Ig/L:	Micrograms per liter
mg/L:	Milligrams per liter
NCP:	National Oil and Hazardous Substances Contingency Plan
NPL:	National Priorities List
OU:	Operable Unit
PCE:	Perchloroethylene; liquids used in degreasing or paint removal.
ppm:	Parts per million by weight
RCRA:	Resource Conservation and Recovery Act
RfD:	Reference Dose
RI/FS:	Remedial Investigation/Feasibility Study
RME:	Reasonable Maximum Exposure
ROD:	Record of Decision
SARA:	Superfund Amendments and Reauthorization Act
SACM:	Superfund Accelerated Cleanup Model
SDDENR:	South Dakota Department of Environment and Natural Resources
SF:	Slope Factor
SVOC:	Semivolatile Organic Compound
TCA:	1, 1, 1,-tetrachloroethane
TCE:	Trichloroethylene
UCLM:	Upper Confidence Limit Mean
USAF:	United States Air Force
UST:	Underground storage tank
VOC:	Volatile Organic Compound
WWTP:	Wastewater Treatment Plant

APPENDIX A

FIGURES



APPENDIX B
TABLES

TABLE 1 OU-11 STUDY AREAS-SUMMARY

Study Area	Potential COCs(a)	Frequency of Detection	Range of Detected Values Ig/L	95% UCLM(b) Conc. Ig/L	Exceeds MCL?	Retained as COC(a)	Ground-Water Action
BG04	TCE	4/11	23-110	43.7	Yes	Yes	Area was evaluated against preliminary remediation goals in Chapter 2.
	1,2-DCE	3/11	0.8-5	2.15	No	No	Includes off-Base Areas east of Base boundary.
	PCE	1/11	23	7.47	Yes	Yes	
	benzene	1/11	0.8	1.02	No	No	
	toluene	1/11	8	3.05	No	No	
	ethylbenzene	1/11	2	1.29	No	No	
	xylenes	1/11	13	4.52	No	No	
	Bis(2-ethylhexyl phthalate)	3/11	6-8	6.10	No	No	
	beta BHC	1/10	0.025	0.017	No	No	
	gamma-chlordane	1/10	0.025	0.017	No	No	
	p,p'-DDT	1/10	0.05	0.034	No	No	
BG05	1,1,1-TCA	1/1	0.8	NA	No	No	Area was evaluated along with BG04 Area because of potential off-Base
	TCE	1/1	7	NA	Yes	Yes(d)	migration of chemicals from this area.
Off-Base	TCE	NA	NA	NA	Yes	Yes(d)	Area was evaluated because subsequent off-Base investigations indicated
BG04/BG05(c)	DCE	NA	NA	NA	No		the presence of contaminants.
	PCE	NA	NA	NA	No		
	TCA	NA	NA	NA	No		
Upgradient OU-6	TCE	2/3	1-4	NA	No	No	No remediation required under CERCLA. Continued monitoring as part of
	1,2-DCE	1/3	52	NA	No	No	Basewide plan. Deferred to State POL program because of presence of
	p,p'-DDE	1/3	0.88	NA	No	No	jet fuel and BTEX constituents.
	Aldrin	1/3	0.22	NA	No	No	
	gamma chlordane	1/3	0.25	NA	No	No	
South Docks	TCE	27/35	1-7,000	680	Yes	Yes	Area was evaluated against preliminary remediation goals in Chapter 2.
	1,2-DCE	17/34	0.9-73	13.1	No	No	
	Bis(2-ethylhexyl)Phthalate,	6/35	3-17	6.07	No	No	
	beta BHC	2/35	0.025	0.014	No	No	

TABLE 1 (Cont)

Study Area	Potential COCs(a)	Frequency of Detection	Range of Detected Values Ig/L	95% UCLM(b) Conc. Ig/L	Exceeds MCL?	Retained as COC(a)	Ground-Water Action
OU-9	1,1-DCA	2/17	0.6-1	1.03	No	No	The northern part of OU-9 was evaluated, along with the South Docks area, against preliminary remediation, goals in Chapter 2. The Building 102 area (eastern part of 0U-9) will be addressed under state petroleum release programs and not under CERCLA. Ground water in the southern part of OU-9 is currently being addressed under a State-led Corrective Action to POL contamination.
	1,2-DCE	10/17	0.5-58	14.8	No	No	
	acetone	7/17	4.5-420	137	No	No	
	benzene	1/17	2	1.18	No	No	
	bromodichloromethane	1/17	1	1	No	No	
	carbon tetrachloride	1/17	0.2	1.05	No	No	
	chloroform	3/17	0.1-0.3	1.02	No	No	
	dibromochloromethane	1/17	0.9	1	No	No	
	PCE	3/17	0.8-20	4.53	Yes	No	
	TCE	10/17	0.5-190	49.6	Yes	Yes	
	di-n-butyl phthalate	1/17	1	5.26	No	No	
	bis(2-ethylhexyl)phthalate	4/17	1-7	5.29	No	No	
	acenaphthene	1/17	1	5.26	No	No	
OU-10 (North Docks)	1,2-DCE	3/21	0.7-36	6.22	No	No	No remediation required under CERCLA due to low detection frequency indicating no plume. Continued monitoring as part of Basewide plan. Area will be addressed under state petroleum release programs and not under CERCLA due to presence of jet fuel and related components (BTF).
	acetone	4/21	18-350	62.0	No	No	
	benzene	3/21	39-3800	418	Yes	No	
	bromodichloromethane	1/21	0.7	1.02	No	No	
	carbon disulfide	4/21	0.2-13	2.68	No	No	
	ethylbenzene	5/21	6-220	39.4	No	No	
	MIK	1/21	44	7.32	No	No	
	PCE	4/21	0.7-30	5.33	Yes	No	
	toluene	1/21	250	37.6	No	No	
	TCE	4/21	0.9-5	1.64	Yes	No	
	xylenes	5/21	2-220	64.3	No	No	
North OU-12	TCE	1/1	10	NA	Yes	No	No remediation required. Continued monitoring as part of Basewide plan.
	1,2-DCE	1/1	16	NA	No	No	
OU-7	None	NA	NA	NA	NA	No	No remediation required.
Pond 003	Benzene	1/1	2	NA	No	No	No remediation required under CERCLA. Deferred to State POL site due to presence of jet fuel and BTEX constituents.

NOTES:

(a) These chemicals were detected during the OU-11 investigation and because of their characteristics were included in the risk assessment.

(b) The 95th percentile upper confidence limit on the mean (95% UCLM).

(c) COC designates chemicals of concern based on the results of the risk assessment. These chemicals are present at high enough concentrations to contribute to risk above the minimum established level for a particular risk assessment. For the EAFB risk assessment, these levels are 1 x 10 for carcinogenic risk or a HI >1 for noncarcinogenic risk. These are EPA guideline values and remediation of chemicals above these risk levels is not always required.

(d) For remediation purposes only. The OU-11 Human Health Risk Assessment did not include BG05 because only low concentrations of TCE were detected. However, because the concentration of TCE in the ground-water sample collected during the RI slightly exceeded the MCL and because of the proximity of BG05 to the Base boundary, it is included as part of Area 2 (along with BG04) in development of remedial alternatives.

(e) Additional investigation (BG04 Pre-Design Site Investigation, RUST 1996) was conducted in the off-Base BG04/BG05 area subsequent to the RI/FS. A risk assessment was not conducted as part of this additional investigation (although the off-Base area was included in the OU-11 RI risk assessment). The potential COC's an COCs retained are based chemical concentrations when compared to MCLs.

TABLE 2 AREA 1 AND AREA 2 EXPOSURE POINT DATA

AREA	POTENTIAL COCs(a)	Frequency of Detection	Range of Detected Values Ig/L	95% UCLM(b) Conc. Ig/L	Retained as COC(c)
Area 1(d)	TCE	27/35	1-7000	680	Yes
	1,2-DCE	17/34	0.9-73	13.1	No
	Bis(2-ethylhexyl) phthalate	6/35	3-17	6.07	No
	beta BHC	2/35	0.025	0.014	No
Area 2 - BG04	1,2-DCE	3/11	0.8-5	2.15	No
	benzene	1/11	0.8	1.02	No
	ethylbenzene	1/11	2	1.29	No
	PCE	1/11	23	7.47	Yes
	toluene	1/11	8	3.05	No
	TCE	4/11	23-110	43.7	Yes
	xylenes	1/11	13	4.52	No
	Bis(2-ethylhexyl) phthalate	3/11	6-8	6.10	No
	beta BHC	1/10	0.025	0.017	No
	gamma-chlordane	1/10	0.025	0.017	No
	p,p'-DDT	1/10	0.05	0.034	No
Area 2 - BG05	TCE	1/1	7	NA	Yes(e)

NOTES:

(a) These chemicals were detected during the OU-11 investigation and because of their characteristics were included in the risk assessment.
(b) The 95th percentile upper confidence limit on the mean (95% UCLM).
(c) COC designates chemicals of concern based on the results of the risk assessment. These chemicals are present at high enough concentrations to contribute to risk above the minimum established level for a particular risk assessment. For the EAFB risk assessment, these levels are >1 x 10-6 for carcinogenic risk or a HI >1 for noncarcinogenic risk. These are EPA guideline values and remediation of chemicals above these risk levels is not always required.
(d) Data presented is from South Docks samples only. North Docks area is being addressed outside CERCLA.
(e) For remediation purposes only. The OU-11 Human Health Risk Assessment did not include BG05 because only low concentrations of TCE were detected. However, because the concentration of TCE in the ground-water sample collected during the RI slightly exceeded the MCL and because of the proximity of BG05 to the Base boundary, it is included as part of Area 2 (along with BG04) in development of remedial alternatives.

TABLE 3 SUMMARY OF SITE RISKS FOR THE SOUTH DOCKS AREA

Total Exposure Point	Exposure Pathway	Chemical of Concern	Noncancer Chronic Daily Intake (CDI) (mg/kg-day)	Cancer Chronic Daily Intake (CDI) (mg/kg-day)	Cancer SF (mg/kg-day)-l	Cancer Risk (CDI x SF)	Noncancer RfD (mg/kg-day)	Noncancer Hazard Index (CDI/RfD)
Future Onsite Residential Adults	1. Ground-Water Ingestion	TCE	1.86E-02	7.98E-03	1.1E-02	8.78E-05	6E-03	3.11E+00
		1,2-DCE	3.62E-04	NA	NA	NA	1E-02	3.62E-02
		Bis(2-ethylhexyl) phthalate						
		beta BHC	1.67E-04	7.16E-05	1.4E-02	1.00E-06	2E-02	8.35E-03
			3.84E-07	1.64E-07	1.8E+00	2.96E-07	NA	NA
		PATHWAY TOTAL				8.91E-05		3.40E+00
	2. Volatile Inhalation/ Dermal Contact (Showering)	TCE	1.86E-02	7.98E-03	1.1E-02	8.78E-05	6E-03	3.11E+00
		1,2-DCE	3.62E-04	NA	NA	NA	1E-02	3.62E-02
		Bis(2-ethylhexyl) phthalate						
		beta BHC	1.67E-04	7.16E-05	1.4E-02	NA	NA	NA
			3.84E-07	1.64E-07	1.8E+00	NA	NA	NA
		PATHWAY TOTAL				8.75E-05		3.14E+00
		TOTAL FOR FUTURE ONSITE RESIDENTIAL ADULTS				1.77E-04		6.54E+00

TABLE 4 SUMMARY OF SITE RISKS FOR THE BG04/BG05 AREA

Total Exposure Point	Exposure Pathway	Chemical of Concern	Noncancer Chronic Daily Intake (CDI) (mg/kg-day)	Cancer Chronic Daily Intake (CDI) (mg/kg-day)	Cancer SF (mg/kg-day)-l	Cancer Risk (CDI x SF)	Noncancer RfD (mg/kg-day)	Noncancer Hazard Index (CDI/RfD)
Future Onsite Residential Adults	1. Ground-Water Ingestion	TCE	1.20E-03	5.13E-04	1.1E-02	5.64E-06	6E-03	1.99E-01
		PCE	2.04E-04	8.75E-05	5.2E-02	4.55E-06	1E-02	2.04E-02
		xylenes	1.24E-04	NA	NA	NA	2E+00	6.15E-05
		toluene	8.37E-05	NA	NA	NA	2E-01	4.18E-04
		1,2-DCE	5.90E-05	NA	NA	NA	1E-02	5.90E-03
		ethylbenzene	3.55E-05	NA	NA	NA	1E-01	3.55E-04
		benzene	2.19E-05	9.39E-06	2.9E-02	2.72E-07	NA	NA
		Bis(2-ethylhexyl) phthalate	1.67E-04	7.16E-05	1.4E-02	1.00E-06	2E-02	8.35E-03
		beta BHC	4.66E-07	2.00E-07	1.8E+00	3.59E-07	NA	NA
		gamma chlordane	4.66E-07	2.00E-07	1.3E+00	2.59E-07	6E-05	7.76E-03
		p,p'-DDT	9.32E-07	3.99E-07	3.4E-01	1.36E-07	5E-04	1.86E-03
	PATHWAY TOTAL					1.22E-05		2.47E-01
	2. Volatile Inhalation Dermal Contact (Showering)(a)	TCE	1.20E-03	5.13E-04	1.1E-02	5.64E-06	6E-03	1.99E-01
		PCE	2.04E-04	8.75E-05	5.2E-02	4.55E-06	1E-02	2.04E-02
		xylenes	1.24E-04	NA	NA	NA	2E+00	6.15E-05
		toluene	8.37E-05	NA	NA	NA	2E-01	4.18E-04
		1,2-DCE	5.90E-05	NA	NA	NA	1E-02	5.90E-03
		ethylbenzene	3.55E-05	NA	NA	NA	1E-01	3.55E-04
		benzene	2.19E-05	9.39E-06	2.9E-02	2.72E-07	NA	NA
		Bis(2-ethylhexyl) phthalate	1.67E-04	7.16E-05	1.4E-02	NA	2E-02	NA
		beta BHC	4.66E-07	2.00E-07	1.8E+00	NA	NA	NA
		gamma chlordane	4.66E-07	2.00E-07	1.3E+00	NA	6E-05	NA
		p,p'-DDT	9.23E-07	3.99E-07	3.4E-01	NA	5E-04	NA
	PATHWAY TOTAL					1.05E-05		2.27E-01
	TOTAL FOR FUTURE ONSITE RESIDENTIAL ADULTS					2.27E-05		4.74E-01

TABLE 4 (CONTINUED)

Total Exposure Point	Exposure Pathway	Chemical of Concern	Noncancer Chronic Daily Intake (CDI) (mg/kg-day)	Cancer Chronic Daily Intake (CDI) (mg/kg-day)	Cancer SF (mg/kg-day)-l	Cancer Risk (CDI x SF)	Noncancer RfD (mg/kg-day)	Noncancer Hazard Index (CDI/RfD)
Future Offsite Residential Adults	1. Ground-Water Ingestion	TCE	1.20E-03	5.13E-04	1.1E-02	5.64E-06	6E-03	1.99E-01
	PATHWAY TOTAL					5.64E-06		1.99E-01
	2. Volatile Inhalation/ Dermal Contact (Showering)(a)	TCE	1.20E-03	5.13E-04	1.1E-02	5.64E-06	6E-03	1.99E-01
	PATHWAY TOTAL					5.64E-06		1.99E-01
	TOTAL FOR FUTURE OFFSITE RESIDENTIAL ADULTS					1.13E-05		3.99E-01

NOTES:
(a) The combined risk from volatile inhalation/dermal contact (i.e., showering) is the same as that for ingestion of ground water.

TABLE 5 EVALUATION OF FEDERAL AND STATE ARARS

A Potentially Applicable of Relevant and Appropriate Federal Standards, Requirements, Criteria and Limitations

Standard Requirement, Criteria, or Limitation	Citations	Description	ARAR Type	Applicability to OU-11
Safe Drinking Water Act	42 USC 300g			
National Primary Drinking Water Standards	40 CFR Pad 141	Establishes health based standards for public water systems (maximum contaminant levels)	Chemical	Relevant and appropriate for Federal Class II aquifer.
National Secondary Drinking Water Standards	40 CFR Part 143	Establishes welfare based standards for the, pubic water systems (secondary maximum contaminant levels)	Chemical	Relevant and appropriate.
Maximum Contaminant Level Goals	Pub. L. No. 99-330, 100 Stat. 642 (1986)	Establishes drinking water quality goals set at levels of unknown or anticipated adverse health effects, with an adequate margin of safety	Chemical	Relevant and appropriate.
Clean Water Act	33 USC 1251-1376			
Water Quality Criteria	40 CFR Part 131	Sets criteria for water quality based on toxicity to aquatic organisms and human, health	Chemical	Relevant and appropriate. Aquifer may be a Federal Class IIA (discharge to surface water).
Criteria and Standards for the National Pollutant Discharge Elimination	40 CFR 125	Establishes criteria and standards for technology-based requirements in permits under the CWA	Chemical	Applicable for discharge to surface water, or to EAFB WWTP.
General Pretreatment Regulations for Existing and Now Sources of Pollution	40 CFR 403	Establishes responsibilities of federal, state, and local government and of the P0TW in providing guidelines for and developing, submitting, approving, and modifying state pretreatment programs. Specifies standards for pretreatment	Action	Applicable for discharge to EAFB WWTP.
Guidelines Establishing Test Procedures for the Analysis of Pollutants	40 CFR 136	Specify analytical procedures for NPDES applications and reports	Action	Applicable for treatment and discharge of ground water.

TABLE 5 (cont.)

Standard Requirement, Criteria, or Limitation	Citations	Description	ARAR Type	Applicability to OU-11
Clean Air Act				
National Primary and Secondary Ambient Air Quality Standard	40 CFR Part 50	Establishes standard for ambient quality to protect public health and welfare.	Action	Applicable
National Emission Standards for Hazardous Air Pollutants	40 CFR Part 61	Establishes regulatory standard for specific air pollutants.	Action	Applicable for alternatives which require discharge to the air following treatment.
Resource Conservation and Recovery Act				
Hazardous Waste Management System: General	40 CFR Part 260	Establishes definitions as well as procedures and criteria for modification or revocation of any provision in 40 CFR Parts 260-265	Action	Applicable for identifying hazardous waste during well placement, or trenching at OU-11.
Identification and Listing of Hazardous Wastes	40 CFR Part 261	Defines those solid wastes which are subject to regulations as hazardous wastes under 40 CFR Parts 262-265	Action	Applicable for identifying hazardous waste during well placement, or trenching at OU-11.
Standards Applicable to Generators of Hazardous Wastes	40 CFR Part 262	Establishes standards for generation hazardous waste	Action	Applicable for transport of hazardous materials off-site.
Standards Applicable to Transporters of Hazardous Wasters	40 CFR Part 263	Establishes standards which apply to persons transporting hazardous waste within to U.S. if the transportation requires a manifest under 40 CFR Part 262	Action	Applicable for any transport of hazardous materials off-site.
Toxic Substances Control Act (TSCA)	40 CFR Part 761	Substances regulated under this rule include, but are not limited to, soils and other materials contaminated as a result of spills	Action	Not an ARAR.
Fish and Wildlife Coordination Act	16 USC 1531-666 40 CFR 6,302(g)	Requires consultation when a federal department or agency proposes or authorizes any modification of a stream or other water body and adequate provision for protection of fish andF wildlife resources	Action	Not an ARAR

TABLE 5 (cont.)

Standard Requirement, Criteria, or Limitation	Citations	Description	ARAR Type	Applicability to OU-11
Endangered Species Act	16 USC 1531-1543 50 CFR Parts 17, 402 40 CFR 6.302(g)	Requires that Federal agencies insure that any action authorized, funded, or carried out by the agency is not likely to jeopardize the continued existence of any threatened or endangered species or destroy or adversely modify critical habitat	Location/Action	Applicable for MW938GO4 Area
Archaeological and Historic Preservation Act	16 USC 469 40 CFR 8.301(c)	Establishes procedures to provide for preservation of historical and archaeological data which might be destroyed through alteration of terrain as a result of federal construction project for a federal licensed activity of program.	Location	Not an ARAR.
Archaeological Resources Protection Act (1979)	93 Stat. 721 16 USC 470	Requires a permit for an excavation or removal of archaeological resources from public or Indian land	Action/Location	Not an ARAR.
Executive Order on Floodplains Management	Exec. order No. 11,988 40 CFR 6.302(b) & Appendix A	Requires federal agencies to evaluate the potential effects of actions they may take in a floodplain to avoid, to the extent possible, the adverse impacts associated with direct and indirect development of a floodplain	Location	Not an ARAR. Area not in 100-year floodplain.
Executive Order on Protection of Wetlands	Exec. Order No. 11,990 40 CFR 6.302(a) & Appendix A	Requires federal agencies to avoid, to the extent possible, the adverse impacts associated with the destruction or loss of wetlands and to avoid support of new construction in wetlands if a practicable alternative exists	Action/Location	Not an ARAR. MW93BG04 and South Docks Areas do not have identified wetland areas.

B. Potentially Applicable or Relevant and Appropriate State Standards, Requirements, Criteria, and Limitations

South Dakota Air Pollution Control Rules	ARSD 74:26:01:09, 24, 25, 26-28	Establishes permit requirements for construction, amendment, and operation of air discharge services	Action	Applicable
South Dakota Water Discharge Permit Rules	ARSD 74:03:18:01-17	Establishes surface water discharge permit applications requirements	Action	Applicable for any groundwater treatment discharge
South Dakota Water Discharge Permit Rules	ARSD 74.03.19.01-08	Establishes surface water permit conditions	Action	Applicable for any groundwater treatment discharge
South Dakota Water Discharge Permit Rules	ARSD 74:03:01	Establishes requirements for individual and small onsite wastewater systems	Action	Applicable for any groundwater treatment plant
South Dakota Water Quality Standards	ARSD 74:03:04:02,10	Defines use of Boxelder Creek and certain tributaries.	Action	Applicable for any groundwater treatment discharge to Boxelder Creek.
South Dakota Ground Water Standards	ARSD 74:03:15	Defines ground water classifications by beneficial use and sets chemical standards.	Chemical	Applicable in evaluating the beneficial use of impacted groundwater.

APPENDIX C

Responsiveness Summary
Remedial Action at Operable Unit 11
Ellsworth Air Force Base, South Dakota

1. Overview

The United States Air Force (USAF) established a public comment period from February 10 to March 10, 1997 for interested parties to review and comment on remedial alternatives considered and described in the Proposed Plan for Operable Unit Eleven (OU-11). The Proposed Plan was prepared by the USAF in cooperation with the U.S. Environmental Protection Agency (EPA) and the South Dakota Department of Environment and Natural Resources (SDDENR).

The USAF also held a public meeting at 7:00 p.m. on February 19, 1997 at the Douglas Middle School in Box Elder, South Dakota to outline the proposed remedy to reduce risk and control potential hazards at Operable Unit 11.

The Responsiveness Summary provides a summary of comments and questions received from the community at the public meeting and during the public comment period as well as the USAF's responses to public comments.

The Responsiveness Summary is organized into the following sections:

- Background on Community Involvement
- Summary of Comments and Questions Received During the Public Comment Period and USAF Responses
- Remaining Concerns

OU-11 has been divided into two areas to aid in project planning. Area 1 is the South Docks Study Area, and Area 2 is the BG04 and BG05 Study Areas.

The selected alternative for Area 1, Ground-Water Extraction and Treatment with Containment, includes the following major components:

- Ground-water removal and treatment in the South Docks Study Area.
- On-Base containment of ground water containing contaminants at concentrations above Federal Maximum Contaminant Levels (MCLs) and State of South Dakota Ground-Water Quality Standards.
- Institutional controls and long-term monitoring.

The selected alternative for Area 2, Ground-Water Containment/Extraction and Treatment, includes the following major components:

- Ground-water removal and treatment along the northeast Base boundary and at areas of high contaminant concentrations on-Base.
- Natural attenuation of low contaminant concentration areas, primarily off-Base.
- Alternative water supply to residents affected by contamination coming from the Base.
- Additional investigation to determine the eastern extent of off-Base ground-water contamination.
- Institutional controls and long-term monitoring.

Collectively, the selected remedies for Area 1 and Area 2 constitute the entire remedial action for OU-11 at EAFB.

2. Background on Community Involvement

On August 30, 1990 EAFB was listed on the EPA's National Priorities List (NPL). A Federal Facilities Agreement (FFA) was signed in January 1992 by the Air Force, EPA, and the State and went into effect on

April 1, 1992. The FFA establishes a procedural framework and schedule for developing, implementing, and monitoring appropriate response actions for EAFB.

- Community relations activities that have taken place at EAFB to date include:
- FFA process - After preparation of the FFA by the USAF, EPA, and SDDENR, the document was published for comment. The FFA became effective April 1, 1992.
- Administrative Record - An Administrative Record for information was established in Building 8203 at EAFB. The Administrative Record contains information used to support USAF decision-making. All the documents in the Administrative Record are available to the public.
- Information repositories - An Administrative Record outline is located at the Rapid City Library (public repository).
- Community Relations Plan (CRP) - The CRP was prepared and has been accepted by EPA and the State of South Dakota and is being implemented. This plan was updated in 1996.
- Restoration Advisory Board (RAB) - The RAB has been formed to facilitate public input in the cleanup and meets quarterly. In addition to USAF, EPA, and South Dakota oversight personnel, the RAB includes community leaders and local representatives from the surrounding area.
- Mailing list - A mailing list of all interested parties in the community is maintained by EAFB and updated regularly.
- Fact sheet - A fact sheet describing the status of the IRP at EAFB was distributed to the mailing list addressees in 1992. A remedial design fact sheet was distributed in October 1996.
- Open house - An informational meeting on the status of the IRP and other environmental efforts at EAFB was held on May 6, 1993. An open house format was also used during the November 16, 1995 Restoration Advisory Board meeting. In addition, during 1996 the Air Force has met with community members numerous times to inform them about ongoing investigations at OU-11.
- Newspaper articles - Articles have been written for the Base newspaper regarding IRP activity.
- Proposed Plan - The proposed plan on this action was distributed to the mailing list addressees for their comments.

The Proposed Plan for this remedial action was distributed to the mailing list addressees for their comments, and additional copies of the Proposed Plan were available at the February 19, 1997 public meeting. A transcript of comments, questions and responses provided during the public meeting was prepared.

3. Summary of Comments and Questions Received During the Public Comment Period and USAF Responses

Part I - Summary and Response to Local Community Concerns

In review of the written transcript of the public meeting, there were no community objections to the proposed remedial action indicated. No written comments were received during the public comment period.

The majority of the comments received during the public meeting were in the form of questions about the remedial investigation findings and the remedial action (i.e., what would be done, how it would be done, and what effects the action might have). Representatives of the USAF were available to provide answers to the questions and also provided an overview presentation during the meeting to describe the proposed actions.

Part II - Comprehensive Response to Specific Technical, Legal and Miscellaneous Questions

The comments and questions below have been numbered in the order they appear in the written transcript of the 19 February 1997 public meeting.

Comment 1. Mr. Myron Mann

Asked for clarification on whether the containment portion of remedial action for the BG04/BG05 would "pump the plume completely dry" prior to injecting the treated water back into the ground.

Response 1: As water flows to the Base boundary, in the soil, the water would be pumped from the ground and treated. Treated ground water will be injected into the ground.

[Treated ground water will be discharged to the Base Waste Water Treatment Plant, a surface water drainage, or be injected back into the aquifer based upon results of predesign studies. The ground-water containment system will prevent ground water and contaminants from moving beyond the Base boundary. However, if water is injected back into the ground, the aquifer will be replenished and wells beyond the Base boundary will not go dry due to remedial action activities. If the aquifer is being replenished with water from other areas beyond the Base boundary, then reinjection of the treated water may not be necessary.]

Comment 2. Mr. Myron Mann

Asked whether that meant that every drop of water within the plume areas would be removed from the ground.

Response 2: Not every drop of water within the plume area would be removed from the ground. The goal is to contain the contamination on-Base and prevent further movement off-Base. This is similar to what has been done at other areas at Ellsworth Air Force Base and is a common practice to prevent movement of contaminants off-Base. Injecting the treated water into the ground has the advantage of speeding up the process of diffusing and dispersing contamination that exists downstream. If the majority of the water is removed and not injected back into the ground, then there would be no more ground water flowing downgradient at the Base boundary.

[However, the aquifer may be receiving water from beyond the Base boundary which would ensure a continuous supply of water to downgradient uncontaminated drinking water wells.]

Response 3: Based on a model type called a batch flush model, it was estimated that the time it would take for natural processes to reduce chemical concentrations to acceptable levels, assuming the source of the contamination is cut off (i.e., contained on-Base), would be 14 years.

Comment 4. Lt. Colonel McBride

Asked if chemicals in the water that are taken up into the plants during phytoremediation remain in the plant and if so, is there any risk to humans or animals (wild or domestic) that may eat the plants.

Response 4: Available information indicates that the majority of organic chemicals taken up into the plants pass completely through them with the water. The rest of the chemicals are broken down by the plant into non-hazardous substances such as carbon dioxide.

4. Remaining Concerns

Based on review of the transcript of the oral comments received during the public meeting, there are no outstanding issues associated with implementation of the proposed remedial action.